Exhibit K

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF OHIO
EASTERN DIVISION

TELEBRANDS CORPORATION, Plaintiff, v. WINSTON PRODUCTS LLC, Defendant.	Case No. 1:23-cv-00631-BMB Judge Bridget Meehan Brennan

SUR-REBUTTAL DECLARATION OF DR. JAMES L. GLANCEY
REGARDING CLAIM CONSTRUCTION

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I, James L. Glancey, hereby declare the following:

I. INTRODUCTION

1. My name is Dr. James L. Glancey. I have been retained as an independent technical expert consultant by Telebrands Corporation ("Telebrands") in connection with the above lawsuit against Winston Products, LLC ("Winston Products"). Specifically, I have been retained to provide my opinions regarding the technology of U.S. Patent Nos. 10,174,870 ("the '870 Patent"); 10,890,278 ("the '278 Patent"); and 11,608,915 ("the '915 Patent") (collectively, the "Patents-in-Suit"), the knowledge that a person of ordinary skill in the art ("POSITA") working in that field of technology would be expected to have, how a POSITA would have understood certain claim terms recited in the Patents-in-Suit, and whether some of those terms are indefinite.

2. In that regard, on December 29, 2023, I submitted the Declaration of Dr. James L. Glancey Regarding Claim Construction of U.S. Patent Nos. 10,174,870; 10,890,278; and 11,608,915 ("Glancey Declaration") in connection with this matter. A true and correct copy of the Glancey Declaration is attached hereto as Exhibit A, which I incorporate in its entirety herein by reference.

3. In addition to the opinions I have submitted in the Glancey Declaration, I have been asked by Telebrands to provide my opinions regarding the Rebuttal Expert Declaration of John M. Feland, III, Ph.D. served on January 16, 2024 ("Feland Declaration") and the opinions expressed therein. I, therefore, provide this declaration in response to the Feland Declaration. Specifically, in this declaration I respond to Dr. Feland's opinions about how a POSITA would interpret the following disputed claim terms and phrases from the Patents-in-Suit:

Group A:

"secured to"

"to couple"

"coupled to"

Group B:

"said inner and outer tubes unsecured between said first and second ends so that said outer tube is not held in frictional contact with said inner tube so that said outer tube can move freely along said inner tube"

"said inner tube is unsecured to said outer tube between said first and second ends so that said outer tube can move freely over said inner tube"

"said flexible inner tube unsecured to said flexible outer tube between said first and second ends so that said flexible outer tube can move freely over said flexible inner tube"

Group C:

(i) "a first restrictor sleeve secured to said first end of said inner and said outer tubes" / "a first restrictor sleeve secured to said first end of said flexible inner tube and said flexible outer tube"

(ii) "a second restrictor sleeve secured to said second end of said inner and said outer tubes" / "a second restrictor sleeve secured to said second end of said flexible inner tube and said flexible outer tube"

Group D:

(i) "a first securing device securing said first restrictor sleeve, said outer tube, and said inner tube to said first coupler" / "a first securing device securing said first restrictor sleeve, said flexible outer tube, and said flexible inner tube to said first coupler"

(ii) "a second securing device securing said another expansion restrictor sleeve, said outer tube and said inner tube to said second coupler" / "a second securing device securing said second expansion restrictor sleeve, said flexible outer tube and said flexible inner tube to said second coupler"

(collectively, the "Disputed Claim Terms").

4. I understand that the parties have reached agreement on the construction of the following claim terms:

- **"first coupler"** means "a first connecting device/fitting";
- **"second coupler"** means "a second connecting device/fitting"; and
- **"extend around an outer circumference of said hose"** means "extend around the outside of the hose,"

(collectively, the "Agreed Claim Terms").

5. This declaration sets forth the opinions that I have formed based on the information available to me as of the date below. The opinions and facts set forth in this declaration are based upon my analysis of the Patents-in-Suit, their file histories, the Glancey Declaration and exhibits cited therein, the Feland Declaration and the exhibits cited therein, the additional materials I have considered as set forth below, the state of the art at the time of the invention, as well as my education, qualifications, knowledge, training, research, teaching, and extensive personal and professional experience in the relevant field.

6. My analysis of the materials submitted in this proceeding is ongoing and I will continue to review any new materials that are provided. This declaration is indicative of only those opinions that I have formed to date and that are set forth herein. I reserve the right to amend, revise, and/or supplement my opinions stated herein based on any new information that may become available to me or my continuing analysis of the materials already provided.

7. I am not currently and have not at any time in the past been an employee of Telebrands. I have no financial interest in Telebrands outside of assisting Telebrands as an expert in this and any related matters.

8. I am being compensated at my normal consulting hourly rate. My compensation is not in any way dependent on the outcome of any matter or the opinions stated herein.

9. My opinions in this case are based on my professional knowledge and experience and are independent of either party's positions.

II. PROFESSIONAL BACKGROUND AND QUALIFICATIONS

10. My opinions stated in this declaration are based on my own personal knowledge and professional experience and judgment. In forming my opinions, I have relied on my extensive knowledge and experience in designing, developing, researching, and teaching the technology discussed and referenced in this declaration.

11. I describe my qualifications and professional experience in the Glancey Declaration and incorporate by reference that discussion here. Glancey Declaration at ¶¶ 6-25.

III. MATERIALS AND OTHER INFORMATION CONSIDERED

12. In preparing this declaration and reaching the conclusions described herein, I have considered the specification, claims, and file history of each of the Patents-in-Suit. I have reviewed Telebrands' Preliminary Proposed Constructions and Supporting Evidence, Winston Products' Preliminary Proposed Constructions and Supporting Evidence, the Glancey Declaration and exhibits cited therein, the Feland Declaration and exhibits cited therein, and the other materials mentioned and cited herein. In addition, my opinions are also based on my education, qualifications, knowledge, training, research, teaching, and extensive personal and professional experience in the relevant field.

13. I reserve the right to supplement, amend, or modify my opinions based on any new information, documents, and/or arguments that are made available to me after the submission of this declaration.

14. To the extent that additional information is presented and becomes available to me during these proceedings, including the briefing and arguments related to claim construction and/or any opposing expert opinions, I reserve the right to amend, supplement, or modify my opinions as appropriate.

IV. SUMMARY OF OPINIONS

15. Based on my analysis of the materials and information I considered in connection with this declaration, it is my opinion that Dr. Feland's proposed constructions attempt to improperly import limitations from the specification into the claims and/or add unnecessary requirements that do not appear to be supported by the claim language, the specification, or the prosecution histories. It is apparent to me, and it would have been apparent to a POSITA at the time of the invention (i.e., 2011) that none of the Disputed Claim Terms require a construction at least because each claim term is easily understandable on its face, and would have been known and understood by a POSITA at the time of the invention.

16. Further, it is my opinion that the various claim terms reciting a "securing device" are not subject to pre America Invents Act 35 U.S.C. § 112, paragraph 6, and even if they are, they should not be construed as narrowly as Dr. Feland has construed them.

V. UNDERSTANDING OF PATENT LAW

17. I am a technical expert and do not offer any legal opinions or interpretations of the law. I previously described my understanding of certain legal principles regarding patent claim construction and related matters under United States patent law in the Glancey Declaration and incorporate that discussion by reference in its entirety here. Glancey Declaration at ¶¶ 31-36.

18. In forming my opinions, I understand that the claims should be interpreted as they would be understood by a POSITA of the patented technology at the time the patent application

was filed. I understand that the claims are to be construed with reference to the patent's claims, the specification, and the prosecution history, in light of the plain meaning of the terms used in the claims, and, if necessary, with reference to other sources of information, such as dictionaries, textbooks, literature, or other patents in the same or related fields, and expert testimony.

VI. PERSON OF ORDINARY SKILL IN THE ART

19. I describe my qualifications of a POSITA in the Glancey Declaration and incorporate that discussion by reference in its entirety here. Glancey Declaration at ¶¶ 37-41.

20. Specifically, in the Glancey Declaration, I explained that the characteristics of a POSITA in connection with the Patents-in-Suit would hold a Bachelor's Degree in Mechanical Engineering or a closely related technical field and would have at least two years of experience in the manufacture, design and/or the application and use of hoses for various types of fluids. *See* Glancey Declaration at ¶ 39. I further explained that this hypothetical person would be capable of performing various design tasks and would understand the basic mechanical and fluid features and operation of expandable and contractible hoses (as disclosed in the Patents-in-Suit); this hypothetical person would also have at least a basic knowledge of fluid mechanics, solid mechanics, and materials science and engineering as they relate to hoses and how hoses generally function to convey fluids from one place to another. *Id.*

21. Dr. Feland has opined that a POSITA would require more skills and knowledge than my proposed definition of a POSITA to be able to effectively practice the technology taught by the Patents-in-Suit. Feland Declaration at ¶ 35. Specifically, in addition to the knowledge and experience set forth in my definition of a POSITA, Dr. Feland asserts that a POSITA would have at least four years of experience in the manufacture, design and/or the application and use of hoses for various types of liquids (instead of two years), and would further have (1) an understanding of how to design components of both rigid and elastomeric polymers; (2) an

understanding of cast metal manufacturing along with post process machining of metal components made with this process; (3) an understanding of how to specify and source fabrics for the manufacturing of the outer hose, made by weaving, knitting, or braiding; and (4) an understanding of how to design, manufacture and utilize manufacturing jigs required to secure the components together for scale manufacturing of the hoses. *Id.* at ¶ 44.

22. As an initial matter, I disagree that a POSITA would require at least four years of experience in the manufacture, design and/or the application and use of hoses for various types of liquids and, for reasons further explained below, stand by my original opinion that two years of experience would be more than sufficient to be able to effectively practice the technology taught by the Patents-in-Suit.

23. Further, I generally agree with Dr. Feland that a POSITA would have the additional understandings he describes. However, it is my opinion that my original definition of a POSITA would also include all of this knowledge. For example, in my original definition of a POSITA, I expressly tie the definition to the Patents-in-Suit and state that a POSITA "would be capable of performing various design tasks and would understand the basic mechanical and fluid features and operation of expandable and contractible hoses" (as taught by the Patents-in-Suit). Glancey Declaration at ¶ 39. This definition makes clear that this POSITA would be intimately familiar with all the components necessary to make the hose disclosed and claimed in the Patents-in-Suit. This includes, among other things, (1) designing and using rigid and elastomeric polymers; (2) cast metal manufacturing along with post process machining of metal components made with this process; (3) specifying and sourcing fabrics for the manufacturing of the outer hose, made by weaving, knitting, or braiding; and (4) utilizing manufacturing jigs required to secure the components together for scale manufacturing of the hoses.

24. Dr. Feland's criticism that my definition of a POSITA failed to mention these "critical skills" is misplaced because my definition of a POSITA expressly requires the hypothetical person to possess *all* the skills necessary to design and build the expandable and contractible hose disclosed and claimed by the Patents-in-Suit, which includes all the skills identified by Dr. Feland, as well as skills that even Dr. Feland failed to mention (such as the skills necessary to couple a flow restrictor to the second coupler). All of these skills identified by Dr. Feland would be learned from a standard accredited mechanical engineering curriculum in conjunction with two years of experience in the manufacture, design and/or the application and use of similar expandable and contractible hoses disclosed by the Patents-in-Suit.

25. Further, Dr. Feland's criticism that several of these critical skills are specialized and not common or required in mechanical engineering curriculums (*see* Feland Declaration at ¶ 42-43) fails to acknowledge that my original definition of a POSITA also required at least two years of experience in the manufacture, design and/or application and use of expandable and contractible hoses disclosed by the Patents-in-Suit. During those two years of experience designing, manufacturing, and using such expandable and contractible hoses, the POSITA would gain all the knowledge they would need to be able to effectively practice the technology taught by the Patents-in-Suit.

26. Put simply, when defining a POSITA it is not necessary or even common to list every skill the POSITA would need to possess to effectively practice the technology taught by the patent in question. Indeed, even Dr. Feland omitted skills necessary for practicing the claimed invention of the Patents-in-Suit (e.g., the skillset needed to couple the flow restrictor to the second coupler). To the contrary, it is my understanding that when defining a POSITA one must simply describe the level of education and level and type of practical experience that this

hypothetical person would need to have to be able to practice the claimed invention. My original definition of a POSITA correctly does that.

27. Moreover, fundamental to this dispute over the definition of a POSITA, Dr. Feland appears to have an unduly restrictive view of what a POSITA would have knowledge of in the expandable and contractible hose field. Based on my extensive and close work with and instruction of undergraduate and graduate mechanical engineering majors, a POSITA under both of our definitions would have far more knowledge and capability with respect to knowing how to design, manufacture and use expandable and contractible hoses disclosed in the Patents-in-Suit than Dr. Feland gives them credit for as evidenced by his opinions, which I believe are flawed in this respect. Specifically, Dr. Feland provides no explanation as to why a POSITA would need four years of practical experience instead of the two years I proposed. He instead simply asserts that a person with just two years would likely have only a single product lifecycle of experience regarding the technology in question, lacking the benefit of learning from mistakes with prior product launches, or having sufficient knowledge of how consumers are using the technology. Feland Declaration at ¶ 34. However, this assertion implicitly acknowledges that a person with two years of practical experience in the expandable hose field indeed would have seen a product through its entire design lifecycle (from design, to manufacturing and finally to testing and performance validation) such that they would have all the necessary experience to effectively practice the claimed invention of the Patents-in-Suit. Further, Dr. Feland does not cite to any evidence to support his conclusion that a POSITA is required to have learned from mistakes from prior product launches or know how consumers are using the technology. These are just requirements conjured up by Dr. Feland without any basis.

28. Dr. Feland also neglects to acknowledge that most accredited undergraduate mechanical engineering curriculums at the time of the invention (i.e., 2011) required students to take advanced courses where they were required to design and develop consumer products and would learn about the entire lifecycle of a product. These "capstone design" courses thus would have provided additional real world practical design experience making it less necessary for a POSITA to have more than two years of practical experience in the expandable and contractible hose field, especially in light of the design experience most undergraduates gained during their collegiate design education at the time of the claimed invention.

29. Dr. Feland also appears to criticize my definition of a POSITA as allegedly "too broad for purposes of accurately characterizing a POSITA capable of reducing the technology disclosed in the Patents-in-Suit to practice." Feland Declaration at ¶ 36; *see also id.* at ¶ 37. That assertion is simply not correct as I specifically stated in the Glancey Declaration that "the characteristics of a POSITA *in connection with the Patents-in-Suit* would hold a Bachelor's Degree in Mechanical Engineering or a closely related technical field and would have at least two years of experience in the manufacture, design and/or the application and use of hoses for various types of fluids." Glancey Declaration at ¶ 39 (emphasis added). I went on to further state that this "hypothetical person would be capable of performing various design tasks and would understand the basic mechanical and fluid features and operation of *expandable and contractible hoses*" – the exact type of hoses discussed and disclosed in the Patents-in-Suit. *Id.* (emphasis added). Thus, my proposed definition of a POSITA is not too broad for the purposes of accurately characterizing a POSITA capable of reducing the technology disclosed in the Patents-in-Suit to practice, as Dr. Feland opines. *See* Feland Declaration at ¶¶ 36-37.

30. As explained in the Professional Background and Qualifications Section of the Glancey Declaration and further shown by my CV (attached as Exhibit A to the Glancey Declaration), I was at least a POSITA (under my definition or Dr. Feland's definition) as of the priority date of the Patents-in-Suit (i.e., 2011).

31. My opinions set forth in the Glancey Declaration and in this declaration, including my opinions concerning the Disputed Claim Terms, are from the perspective of a POSITA, as set forth above and in the Glancey Declaration, at the time of the invention. Moreover, these opinions would not change if viewed from the perspective of a POSITA as defined by Dr. Feland.

VII. THE PATENTS-IN-SUIT

32. As stated in the Glancey Declaration, I have been retained as an independent technical expert consultant by Telebrands to provide my opinions regarding the technology of U.S. Patent Nos. 10,174,870; 10,890,278; and 11,608,915.

33. As I stated in the Glancey Declaration, the Patents-in-Suit are generally directed to an expandable and contractible hose that automatically expands to an extended state when pressurized water is introduced into the hose and automatically contracts back to a contracted state when the pressurized water within the hose is subsequently released. '870 Patent at 1:39-43.[1]

34. I have reviewed the "Patents-in-Suit" Section of the Feland Declaration and note that it contains many misstatements. Feland Declaration at ¶¶ 47-57. However, for the purpose of this declaration I note that it is not necessary to address these misstatements now. I reserve

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[1] Unless otherwise noted, I cite to the '870 Patent specification throughout this declaration when referring to the Patents-in-Suit because the specifications of the three Patents-in-Suit are substantively identical.

the right to address any and all of Dr. Feland's misstatements in a later declaration to the extent it becomes necessary.

VIII. OPINIONS CONCERNING CLAIM CONSTRUCTION

35. Each of the below claim terms have been identified by Winston Products as needing to be construed. As explained in the Glancey Declaration and below, it is my opinion that none of the below Disputed Claim Terms require a construction at least because they are unambiguous and would have all been easily understood by a POSITA at the time of the invention. It is further my opinion that, for all the Disputed Claim Terms, the constructions offered by Winston Products and Dr. Feland contain limitations that do not appear to be justified by the language of the claims, the specification, or the prosecution histories of the Patents-in-Suit.

36. As an initial matter, I disagree with Dr. Feland's statements and opinions in paragraphs 59-62 of the Feland Declaration. As is clear from the Glancey Declaration and my opinions set forth herein, I am not attempting to have the Court abdicate its role in construing the claims. Indeed, from my understanding, it is quite common for Courts not to construe easily understandable claim terms, like the ones we have here. Moreover, contrary to Dr. Feland's assertion, not construing the Disputed Claim Terms would not lead to ambiguity (inherent or otherwise) regarding their meaning and scope. Lastly, my analysis set forth in the Glancey Declaration does not generate ambiguity regarding the Disputed Claim Terms.

37. The below claim terms have been grouped together to the extent they incorporate common subject matter or involve similar issues.

A. Group A: "secured to" / "to couple" / "coupled to"

38. As I stated in the Glancey Declaration, it is my opinion that the terms "secured to," "to couple," and "coupled to" are unambiguous and well-known terms that are easily

understood on their face and, therefore, do not require a construction. My opinions and analyses from the Glancey Declaration regarding this grouping of claim terms are hereby incorporated by reference in their entirety. Glancey Declaration at ¶¶ 45-49.

39. To be clear, my opinion is that upon taking into consideration the claims, specification and prosecution histories of the Patents-in-Suit, these claim terms are clear on their face to a POSITA. Based on my extensive experience in the field of mechanical engineering and fluid systems including hoses, a POSITA would know immediately what was being referred to by the words "secured to," "to couple," and "coupled to," and certainly at the time of the claimed invention disclosed in the Patents-in-Suit.

40. I, therefore, do not believe these claim terms require any construction by the Court, given that they are clear on their face to a POSITA.

41. Dr. Feland proposes the following constructions for these terms:

- "secured to" means "affixed or attached firmly so it cannot be removed from";
- "to couple" means "to removably connect"; and
- "coupled to" means "removably connected to."

Feland Declaration at ¶ 81.

42. I disagree with these constructions because they deviate significantly from their plain and ordinary meaning.

43. Specifically, Dr. Feland's proposed constructions for these three claim terms suffer from the same problem – they all attempt to improperly interject extraneous characterizations of the type of attachment or connection, i.e., affixed or attached ***firmly so it cannot be removed***, or ***removably*** connected, into the claim terms. I disagree that a POSITA would have understood these claim terms to include such narrow limitations because such

constructions clearly depart from the plain language of the claims, are not supported by the specification, and are not otherwise required by inventor lexicography or disavowal, nor are those concepts necessary to make the claimed invention.

44. Notably, Dr. Feland appears to pluck these definitions out of thin air because the phrase "firmly so it cannot be removed" or any similar phrase does not appear anywhere in the claims, the specification, or prosecution histories of the Patents-in-Suit, and the term "removably," likewise does not appear anywhere in the specification and only appears once in a dependent claim.

45. As an initial matter, the patents' sole use of the term "removeably" is fatal to Dr. Feland's constructions because it expressly contradicts his entire argument. Specifically, "removeably" appears in Claim 11 of the '870 Patent, Claim 11 of the '278 Patent and Claim 10 of the '915 Patent and is used to describe the connection of the flow restricting nozzle to the hose. These claims each recite "wherein said flow restrictor is a nozzle which is ***removeably secured*** to said hose." '870 Patent, Claim 11; '278 Patent, Claim 11; and '915 Patent, Claim 10 (emphasis added). If the Court were to adopt Dr. Feland's construction of "secured" to mean "affixed or attached firmly so it cannot be removed" it would render each of these claims inoperable because the claims expressly require the nozzle to be ***removeably*** secured or attached to the hose. A POSITA would therefore not understand "secured" to mean "affixed or attached firmly ***so it cannot be removed***" in the context of these claims because doing so would render the claims completely inoperable. As such, a POSITA reading all of the claims together would not understand the phrase "secured to" alone means "affixed or attached firmly so it cannot be removed" because, after reading Claim 11 of the '870 Patent, Claim 11 of the '278 Patent and

Claim 10 of the '915 Patent, a POSITA would understand that such a narrow definition is clearly untenable under these circumstances.

46. Further, as a general matter, there is no reason (based on the intrinsic record or otherwise), in my opinion, that a POSITA at the time of the invention would narrow the meaning of these well understood terms to interject unnecessary limitations as Dr. Feland suggests. Indeed, none of the claims, specification, or prosecution histories of the Patents-in-Suit require these terms to be read so narrowly and Dr. Feland has not shown otherwise.

47. Moreover, as demonstrated below, *none* of the cited dictionary definitions support Dr. Feland's narrow constructions of these terms.

48. Below are the relevant definitions of "secured to":

- The Color Oxford English Dictionary, 2011: defines the verb use of "secure" as "firmly fix or fasten" and the adjective use of "secure" as "fixed or fastened so as not to give way or become loose" (attached as Exhibit 1 to the Feland Declaration);
- The Concise Oxford English Dictionary, 2008 defines the verb use of "secure" as "fix or fasten securely" and the adjective use of "secure" as "fixed or fastened so as not to give way, become loose, or be lost" (attached as Exhibit 2 to the Feland Declaration);
- The Oxford English Dictionary, Second Edition, Volume III, 1989: defines the verb use of "secured" as "firmly fastened" and defines the verb use of "secure" as "to make fast or firm" (attached as Exhibit 3 to the Feland Declaration);

- Webster's New World Dictionary and Thesaurus, Second Edition, 2013: (1) defines the verb use of "secure" to mean "to make firm, fast, etc.," (2) identifies the synonyms of "secure" as " [to fasten], settle, lock, bind," and (3) defines the adjective use of "secure" as "firm, stable, etc. [make the knot secure]" (attached as Exhibit B to the Glancey Declaration);
- Merriam-Webster's Collegiate Dictionary, Eleventh Dictionary, 2020: defines the verb use of "secure" to mean "to make fast" (attached hereto as Exhibit B); and
- Webster's American English Dictionary, New Edition, 2022: defines the verb use of "secure" as "fasten safely" (attached hereto as Exhibit C).

49. As clearly demonstrated by every definition of "secure" set forth above, not one definition states or suggests that "secure" means the attachment is such that it is permanent – i.e., that *it cannot be removed or undone*. Indeed, a POSITA would have understood the exact opposite of what Dr. Feland proposes – that securing can involve either permanent or non-permanent attachments. That is, a POSITA would readily understand that to firmly attach, fasten, or fix one object to another simply means the attachment is firm or tight – it does not mean the objects are attached such that they cannot be removed. Dr. Feland does not cite to any evidence to the contrary. It is therefore my opinion that there is nothing in the intrinsic or extrinsic record that would require the claim term "secured to" to be limited as Dr. Feland contends, and a POSITA would not read such a narrow limitation into this claim term.

50. Further, the above definitions of "secured" comport with the general understanding that one can "secure" the threaded end of hose to a spigot (i.e., make the connection between the end of the hose and spigot tight or firm) while still always being able to

remove the hose from the spigot as desired. Dr. Feland's requirement that "secured to" means it cannot be removed is simply untenable and contrary to the plain and ordinary meaning of the term as shown by the above definitions and common sense.

51. Likewise, as demonstrated below, *none* of the cited dictionary definitions support Dr. Feland's constructions of "to couple," or "coupled to."

- The Color Oxford English Dictionary, 2011: defines the verb use of "couple" as "to connect or combine" (attached as Exhibit 1 to the Feland Declaration);
- The Concise Oxford English Dictionary, 2008 defines the verb use of "couple" as "combine" or "connect (a railway or piece of equipment) to another" (attached as Exhibit 2 to the Feland Declaration);
- The Oxford English Dictionary, Second Edition, Volume III, 1989: defines the verb use of "couple" generally as "to fasten or link together" and "to join or connect in any way," and defines the verb use of "couple" with respect to mechanical systems as "to connect (railway carriages) by a coupling" (attached as Exhibit 3 to the Feland Declaration);
- Webster's New World Dictionary and Thesaurus, Second Edition, 2013: defines the verb use of "couple" to mean "to link or unite" and identifies "unite, come together, link" as synonyms of "couple" (attached as Exhibit B to the Glancey Declaration);
- Merriam-Webster's Collegiate Dictionary, Eleventh Dictionary, 2020: defines the verb use of "couple" to mean "to connect for consideration together" and "to fasten together" (attached hereto as Exhibit B); and
- Webster's American English Dictionary, New Edition, 2022: defines the verb use of "couple" as "link together" (attached hereto as Exhibit C).

52. As clearly demonstrated by every definition of "couple" set forth above, not one definition states or suggests that "couple" means the connection is such that it *must* be removable. Indeed, a POSITA would have understood the exact opposite of what Dr. Feland proposes – that coupling can involve either permanent or non-permanent connections, and in some cases even semi-permanent connections. That is, a POSITA would readily understand that to couple two objects does not mean it has to be a removable connection. Dr. Feland does not cite to any evidence to the contrary. It is therefore my opinion that there is nothing in the intrinsic or extrinsic record that would require the claim terms "to couple" and "coupled to" to be limited as Dr. Feland contends, and a POSITA would not read such a narrow limitation into these claim terms.

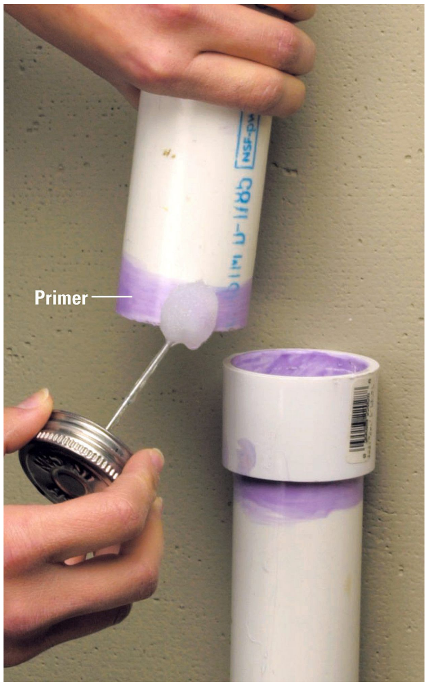
53. Further, the above definitions of "couple" comport with the general understanding that one can "couple" or connect two objects together such that the connection can be either a removable connection or a permanent connection. Dr. Feland's requirement, on the other hand, that "to couple" and "coupled to" means that the connection *must* be removable is simply untenable and contrary to the plain and ordinary meaning of the term as shown by the above definitions and common sense.

54. Dr. Feland uses the example of the way railway cars are coupled to support his constructions of "to couple" and "coupled to" requiring a removable connection. Feland Declaration at ¶ 67. This example misses the mark. Of course railway cars would need to be coupled and decoupled but that does not mean that "to couple" and "coupled to" *requires* a removable connection. It just shows that in the railway car example the railway cars *can be* and usually need to be removably coupled. More fundamentally, these couplings have nothing to do with fluid systems. For fluid systems, a POSITA would readily understand that "to couple" two

items together can include any of the following types of connections: 1) removable connection, 2) semi-permanent connection, or 3) permanent connection.

55. A removable connection in a fluid system can be, for example, a threaded connection between a hose and a spigot, as illustrated below. ASTM F412-09 (2009), *Standard Terminology Relating to Plastic Piping Systems*, identifies and defines a gasketed spigot joint (e.g., connection or coupling) as "a connection between piping components consisting of a bell end on one component [e.g., the hose], an elastomeric gasket between the components, and a spigot end on the other component [e.g., the water source]." Exhibit D, ASTM F412-09 at 8.

56. A permanent connection in a fluid system can be, for example, a coupling with adhesively bonded joints, crimping, or even soldered joints. An adhesively bonded joint is illustrated below.



As shown in the image above, adhesives are commonly used with PVC (polyvinyl chloride plastic (PVC) and chlorinated polyvinyl chloride (CPVC) fittings. ASTM F412-09 (2009), *Standard Terminology Relating to Plastic Piping Systems* identifies and defines an adhesively bonded joint (e.g., connection or coupling) as "a joint made using an adhesive to bond the piping components." Exhibit D, ASTM F412-09 at 8. Another method of creating permanent connections in fluid systems (like the expandable hose of the Patents-in-Suit) uses crimping to permanently deform a component in order to couple fluid conveying components. An example of these crimping type methods of coupling is standardized in ASTM F2159-10 "*Standard Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing*" which was published in 2010 and first approved in 2001. *See* Exhibit E. This standard for fittings used in fluid systems outlines requirements for crimp rings made of both copper and stainless steel intended for use in 100 psi (690 kPa) cold- and hot-water distribution systems operating at temperatures up to and including 180°F (82°C). *Id.* at 1.

The third option that facilities "coupling" two pieces of fluid conduits is a semi-permanent coupler, which uses compression to connect and seal the fluid system components. ASTM F412-09 (2009), *Standard Terminology Relating to Plastic Piping Systems*, identifies and defines a compression joint (e.g., connection or coupling) as a "mechanical joint made by deforming a sealing member to form a pressure seal between the fitting or pipe bell and the pipe or tube." Exhibit D at 8.

This connection (e.g., coupling) method is now commonly used by engineers and plumbers to connect pipes and/or tubes that are usually 2 inches or less in diameter. These types of couplers are referred to as compression fittings (and sometimes in the trade of plumbing as Shark-Bites – a trademarked name of a manufacturer of these types of compression fittings). In light of the above, a POSITA would readily understand that "to couple" two items together can include any of a removable connection, a semi-permanent connection, or a permanent connection.

57. As already cited, these aforementioned fluid couplers and connection methods are defined and standardized in many national standards including, for example, in the standard ASTM F412-09, "*Standard Terminology Relating to Plastic Piping Systems*," which was first published in 1975. *E.g.*, Exhibit D at 8. This standard provides more appropriate examples of

fluid couplers (as would be used in connection with the Patents-in-Suit) than the mechanical railway car coupler example provided by Dr. Feland.

58. Overall, the point is that the mechanical couplers (like the mechanical couplers used for the railway cars cited by Dr. Feland and referenced in one of Dr. Feland's dictionary definitions) are different than the couplers used for pipes and hoses conveying a liquid. Generally speaking, mechanical couplers almost always must be non-permanent or removable to facilitate disconnecting, disassembly and/or repair of mechanical components or devices, while, as explained above, fluid couplers can be removable, semi-permanent, or permanent. Furthermore, coupling fluid components together that convey a fluid must consider fluid leakage, which is different than with a mechanical coupling connecting mechanical components. A POSITA, knowing all of this, would therefore not construe the terms "to couple" and "coupled to" as requiring a removable connection, as Dr. Feland suggestions.

59. Moreover, Dr. Feland's analysis for improperly interjecting limitations into these claims terms is flawed for at least two reasons.

60. First, and as an initial matter, Dr. Feland bases his entire opinion on the false premise that these claim terms must be construed according to his proposed definitions in order "to help those seeking to reduce the claimed hose to practice" because, according to Dr. Feland, "these terms cannot have the overlapping meaning suggested by the words' plain and ordinary meaning." Feland Declaration at ¶ 63. Yet, Dr. Feland never explains why a POSITA would not be able to reduce the claimed hose to practice without his proposed constructions. That is because a POSITA would have no problem reducing the claimed hose to practice by simply applying the plain and ordinary meaning of these claim terms in light of the claims, specification,

and prosecution histories of the Patents-in-Suit, as well as their dictionary definitions set forth above.

61. Even more problematic for Dr. Feland, he never explains why his specific proposed constructions are necessary to achieve his alleged goal of helping those seeking to reduce the claimed hose to practice. That is because Dr. Feland's proposed constructions are not necessary to assist a POSITA in reducing the claimed hose to practice because, again, a POSITA would have no problem reducing the claimed hose to practice by simply applying the plain and ordinary meaning of these claim terms.

62. Second, Dr. Feland's analysis improperly imports limitations from the specification into these claim terms. Specifically, Dr. Feland asserts that because the specification allegedly shows that "secured" components are not meant to be removed from each other (Feland Declaration at ¶ 71), and that "coupled" components are meant to be removable (*id.* at ¶ 64) that that somehow justifies importing these limitations into the claim terms. I disagree with Dr. Feland.

63. In particular, Dr. Feland's assertion that the "Patents-in-Suit carefully separate the concepts of securing components together from the notion of removably connecting components or coupling these components" is simply wrong. *Id.* at ¶ 71. Indeed, there are several instances in the Patents-in-Suit where "secure" or "secured" is used to describe a removable attachment instead of a permanent attachment. For this reason alone, Dr. Feland's opinions regarding the construction of these claim terms falls apart and are therefore not correct. Below are the relevant excerpts from the '870 Patent that refute Dr. Feland's assertions:

- "Claim 11. The hose of claim 1 wherein said flow restrictor is a nozzle which is ***removeably secured*** to said hose." ('870 Patent at 16:7-8) (emphasis added);
  - Here, the claim expressly requires the nozzle to be removably secured to the hose, such that if "secured" meant "affixed or attached firmly so it cannot be removed," as Dr. Feland asserts, it would render the express claim requirement that the nozzle be removably attached to the hose inoperable. How could an object be removably attached to another object such that it is also attached so that it cannot be removed? That would be nonsensical, and counter to what a POSITA would understand.
- "For example, when the hose 10 of the present invention is utilized as a garden hose around a house, coupler 18 is ***secured*** to a faucet or water outlet on an exterior wall of the house." ('870 Patent at 10:1-4) (emphasis added);
  - Here, the specification is explaining that the coupler of the hose is ***secured*** to a faucet. By Dr. Feland's own admission this type of connection is meant to be a removable connection because if it was not a removable connection "the claimed hose would be limited in its utility, potentially including permanent attachment to a faucet." Feland Declaration at ¶ 66; *see also id.* at ¶ 64 (Dr. Feland explaining that the coupling of the claimed hose to sources of pressurized fluid "represent[s] a removable connection"), and at ¶ 64(a).
- "A nozzle or other distributor can be ***secured*** to male coupler 16 at the opposite end of hose." ('870 Patent at 10:11-12) (emphasis added); and
  - Here, again, the specification is explaining that the nozzle or sprayer is ***secured*** to the male coupler 16. Once again, by Dr. Feland's own admission this type of connection is meant to be a removable connection. Feland Declaration at ¶ 64 (Dr. Feland explaining that the coupling of the

nozzle to the hose "represent[s] a removable connection"); *see also id.* at ¶ 64(e).

- "A user of the present invention can take hose 10 from a stored condition, ***secure*** a nozzle or other flow restrictor on one end of the hose, ***secure*** the hose 10 to a water faucet and turn on the water without the fear of the hose becoming entangled or kinked or without the need to untangle or unkink the hose." ('870 Patent at 12:28-33) (emphasis added);
    - Here, again, the specification is explaining that hose can be ***secured*** to a water faucet and that the nozzle can be ***secured*** to one end of the hose – both of which are removable connections by Dr. Feland's own admissions. Feland Declaration at ¶ 64, 66.

64. Even if Dr. Feland's assertions were correct that the specification shows that "secured" components are not meant to be removed from each other (Feland Declaration at ¶ 71), and that "coupled" components are meant to be removably connected (*id.* at ¶ 64), a POSITA would still not import these narrow limitations into the claim terms because a POSITA would understand that (1) the specification is meant to simply provide exemplary embodiments (not limiting examples), and (2) as explained above, the plain and ordinary meaning of these terms is not so limiting. Moreover, there is nothing in the claims, the specification, or the prosecution histories of the Patents-in-Suit that inform a POSITA that these claim terms are required to be limited as Dr. Feland suggests. And, Dr. Feland does not point to any such evidence from the intrinsic record. Said another way, Dr. Feland's requirement that "secured" requires a fixing or fastening that cannot be removed and that "couple" requires a removable connection impose limitations not required by the claims, specification, or prosecution histories of the Patents-in-Suit.

65. Indeed, nowhere in the claims, specification, or prosecution histories of the Patents-in-Suit does it state or even suggest that being "secured to" requires an attachment that

cannot be removed, or that "to couple" is or must only be used for removable connections. To the contrary, as explained above, a POSITA would understand that being "secured" can be either a removable or permanent attachment, and that "couple" can be any of a removable, semi-permanent, or permanent connection, and thus these claim terms are not limited to any particular type of attachment or connection.

66. Moreover, by requiring "couple" to refer only to a removable connection and "secured" to refer only to a permanent attachment, Dr. Feland is removing embodiments from the scope of the claims that a POSITA would otherwise understand are covered by the claims. For example, as explained above, a POSITA would readily understand that coupling two components together in a fluid system could be accomplished by any of a removeable, semi-permanent, or permanent connection. And, likewise, a POSITA would readily understand that securing two components together in a fluid system could result in a removable or permanent attachment. For example, a POSITA would understand that securing a coupler to the inner and outer tubes of a hose could be done by clamping the components together. As shown and explained further below, a POSITA would also readily understand that clamping two components together does not create a permanent connection and in fact is designed to be a "reversible" connection so as to allow the clamp to be adjusted and/or removed in order to replace failed or damaged components.

67. Thus, it is my opinion that Dr. Feland's proposed constructions of these claims terms improperly limits their full breadth, as a POSITA would readily understand them.

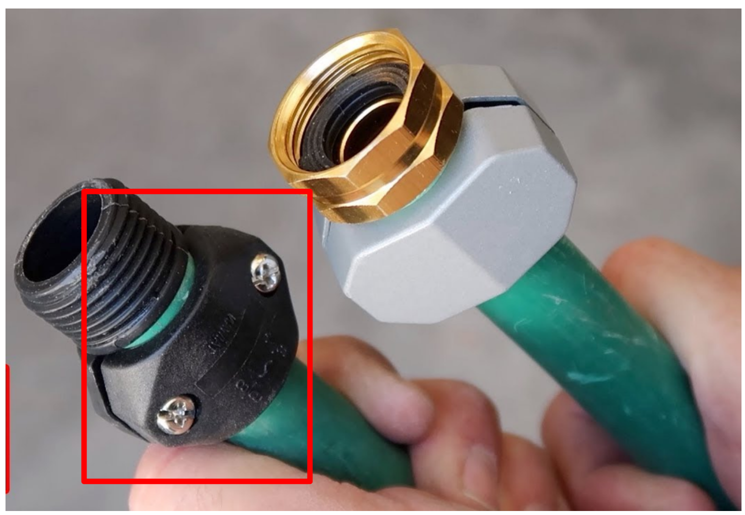
68. To the extent Dr. Feland relies on the claim term "unsecured" to further inform his improper definition of the claim term "secured," I disagree with Dr. Feland that it does. Feland Declaration at ¶ 70. Dr. Feland asserts, without any explanation, that the inventors of the

Patents-in-Suit "use[] the term 'unsecured' to describe a situation where the inner tube and outer tube are not affixed or firmly attached to each other between the first and second ends." *Id.* However, the claims say nothing about how the inner tube and outer tube are unsecured – just that they are unsecured (i.e., unattached, regardless of whether it is firmly or loosely). Dr. Feland then goes on to conclude that because the claims state that the outer tube can move freely over the inner tube that that somehow this means that the outer tube and inner tube are not "attached firmly." I disagree with this conclusion. To the contrary, it is because the outer tube and inner tube are not secured or fastened between their ends (i.e., they are only secured at their ends) that the outer tube is able move freely over the inner tube. Said another way, it makes no difference that they are not firmly attached (or loosely attached, for that matter) – just that they are not attached between the couplers thus enabling them to move relative to each other. Moreover, the specification of the Patents-in-Suit simply explains that the outer tube is "unattached, unconnected, unbonded, and unsecured to the inner tube along the entire length of the inner tube, between the first end and the second end." '870 Patent at 7:10-13; *see also id.* at 9:4-9; 12:7-11; 12:64-13:2. Notably, there is not mention that the outer tube and inner tube are not *firmly* attached, as Dr. Feland asserts (or even loosely attached).

69. Dr. Feland further opines that the '870 Patent teaches that "secured components are not meant to be removed from each other" because, as he asserts, clamping and swaging (some of the methods used to secure the inner and outer tubes to the couplers) "would require some portion of the coupler or securing device to be deformed irreversibly." Feland Declaration at ¶ 71. I disagree. Clamping does not result in any component being deformed permanently, nor is the coupling irreversible. To the contrary, many clamped connections and assemblies are specifically designed to be reversible because the clamp is often designed to be removed from

the assembled components, thus allowing disassembly. Clamps are designed to be removed in order to, among other reasons, reset the clamp to make the connection tighter or looser as needed, or disassemble components in order to replace any failed component(s).

70. Further, clamps, as used in the Patents-in-Suit, may be removable connections, and, more importantly, nothing in the claims, specification or prosecution histories of the Patents-in-Suit require a non-removable or permanent clamp. Indeed, clamps used for garden hose applications, as shown below, are designed to be removable (clamp identified by the red box). As shown in the below example, the clamp can be tightened or removed using a Philips head screw driver.



71. Further, to the extent Dr. Feland asserts that these claim terms need to be construed to avoid any potential overlapping of meanings suggested by "secured to," "to couple," and "coupled to," that issue (to the extent it is an issue) could be addressed without requiring the very narrow limitations Dr. Feland is attempting to import into these claim terms – for example, by simply applying their respective plain and ordinary meaning.

72. Lastly, ultimately, Dr. Feland is taking the untenable position that just because a connection is described as *capable* of being removable that means it is *required* to be removable.

I disagree with this general conclusion. It is simply common sense that a connection may be described as removable without requiring that it be removable. The same is true for Dr. Feland's position on "secured" – an attachment may be described as permanent (which is not even the case here) without requiring that the attachment be such that it cannot be removed.

73. In light of the above and as explained in the Glancey Declaration, it is my opinion that a POSITA at the time of the invention would have easily understood and been able to apply these well-known terms based on the claim language and the specification of the Patents-in-Suit and, importantly, would not have understood them to be limited as Dr. Feland proposes. As such, it is my opinion that no construction of these terms is necessary.

B. Group B:

"said inner and outer tubes unsecured between said first and second ends so that said outer tube is not held in frictional contact with said inner tube so that said outer tube can move freely along said inner tube"

"said inner tube is unsecured to said outer tube between said first and second ends so that said outer tube can move freely over said inner tube"

"said flexible inner tube unsecured to said flexible outer tube between said first and second ends so that said flexible outer tube can move freely over said flexible inner tube"

74. As I stated in the Glancey Declaration, it is my opinion that these claim terms or phrases do not require a construction at least because they are easily understandable to a POSITA on their face, and also because each phrase is defined by the language of the claim itself. My opinions and analyses from the Glancey Declaration regarding this grouping of claim terms are hereby incorporated by reference in their entirety. Glancey Declaration at ¶¶ 50-53.

75. To be clear, my opinion is that upon taking into consideration the claims, specification and prosecution histories of the Patents-in-Suit, these claim terms are clear on their face to a POSITA. Based on my extensive experience in the field of mechanical engineering and

fluid systems and hoses, a POSITA would know immediately what was being referred to by these claim phrases and certainly at the time of the claimed invention disclosed in the Patents-in-Suit.

76. A POSITA at the time of the invention would understand that a plain reading of these claim terms simply describes an inner and an outer tube that are not attached to each other except at their respective first and second ends so that the outer tube can move freely along the inner tube – nothing more. That is, no further definition or construction of these claim terms is necessary because the meaning of these claim terms are clear on their face given their plain and unambiguous language. The specification also supports this clear understanding. Notably, the specification states that the "outer tube is unattached, unconnected, unbonded, and unsecured to the inner tube along the entire length of the inner tube, between the first end and the second end, so that the outer tube can move freely with respect to the inner tube along the entire length of the inner tube between the first end and the second end." '870 Patent at 7:10-16; *see also id.* at 1:47-53 ("The hose is comprised of an elastic inner tube and a separate and distinct non-elastic outer tube positioned around the circumference of the inner tube and attached and connected to the inner tube only at both ends and is separated, unattached[,] unbonded and unconnected from the inner tube along the entire length of the hose between the first end and the second end."); 9:1-9, 12:1-33, and 12:45-13:27.

77. I, therefore, do not believe these claim terms require any construction by the Court, given that they would be abundantly clear on their face to a POSITA.

78. Dr. Feland asserts that these claim terms should be construed to mean: "the inner and outer tubes are ***not affixed or attached firmly except at their first and second ends*** so that the outer tube can move freely along the inner tube between the couplers." Feland Declaration at

¶ 91 (emphasis added).[2] Dr. Feland's proposed construction adds the above-emphasized unnecessary limitation absent any indicia of inventor lexicography or disclaimer. In fact, Dr. Feland's proposed construction appears to entirely rewrite the claim, requiring the inner and outer tubes to be "affixed or attached firmly" at their respective ends. But there is nothing in the claim language that mentions or requires this proposed additional limitation. Indeed, it is my opinion that a POSITA would not understand these claim terms to require this additional narrowing limitation that Dr. Feland seeks to inappropriately read into the claims, nor is this concept necessary to make the claimed invention. There is simply no basis to add this limitation to these claim terms.

79. To put it plainly, it appears that Dr. Feland is merely attempting to carry his improper opinions with respect to the claim term "secured to" through to the claim term "unsecured." That is, Dr. Feland appears to be attempting to require that the outer and inner tubes be affixed or attached firmly at their respective ends. I disagree that a POSITA would read these claim terms to require such a limitation. Indeed, as explained above, requiring a particular attachment (i.e., a firm attachment or even a loose attachment) is not supported by the claim language, specification or prosecution histories of the Patents-in-Suit.

80. Moreover, the claims say nothing about how the inner tube and outer tube are unsecured – just that they are unsecured (i.e., unattached, regardless of whether it is firmly or loosely). The specification is likewise silent about how the inner and outer tubes are unsecured –

[2] While Dr. Feland's proposed construction for each of the three claim terms in this grouping are slightly different (due to the slight difference in claim language), they all attempt to improperly narrow the claim terms in the same manner. As such, my discussion of this construction applies equally to the other two constructions Dr. Feland proposes for this grouping of claim terms.

just that they are "unconnected, unattached, unsecured, or unbonded." (i.e., unattached, regardless of whether it is firmly or loosely). '870 Patent at 12:7-11.

81. Further, Dr. Feland's construction interjects ambiguity or confusion into the claim where the claim term is otherwise very easily understandable. For example, Dr. Feland's requirement that the inner and outer tubes are not affixed or attached firmly except at their first and second ends implies that the inner and outer tubes are otherwise attached between their first and second ends but that it is just not a firm attachment. Such an understanding goes completely against a critical feature of the invention. Indeed, it is because the outer tube and inner tube are not secured or attached between their ends (i.e., they are only attached *at* their ends) that the outer tube is able move freely over the inner tube. '870 Patent at 12:7-11 ("Because the outer tube is unconnected, unattached, unsecured, or unbonded to the inner tube along the entire length of the hose between the first end and the second end, the soft fabric material of the outer tube 12 can move freely with respect to the inner tube [14]."). A critical innovation of the Patents-in-Suit would be defeated if the inner and outer tubes were secured between the first and second ends of the outer and inner tubes, as Dr. Feland's proposed constructions imply and allow.

82. To the extent Dr. Feland is using his incorrect construction of "secured to" as meaning "affixed or attached firmly so it cannot be removed from" to support his construction that "unsecured" should mean "not affixed or attached firmly," I disagree with Dr. Feland for all the reasons stated in the preceding section.

83. To the extent Dr. Feland is asserting that because the outer tube can move freely over the inner tube that that somehow means that the outer tube and inner tube are not "attached firmly" – I disagree with this assertion. To the contrary, it is because the outer tube and inner tube are not secured or attached between their ends at all (i.e., they are only secured at their ends)

that the outer tube is able move freely over the inner tube. Said another way, it makes no difference that they are not firmly attached (or loosely attached, for that matter) – just that they are not attached thus facilitating relative motion between the two tubes. Moreover, the specification of the Patents-in-Suit simply explains that the outer tube is "unattached, unconnected, unbonded, and unsecured to the inner tube along the entire length of the inner tube, between the first end and the second end." '870 Patent at 7:10-13; *see also id.* at 9:4-9; 12:7-11; 12:64-13:2.

84. Lastly, Dr. Feland's decision to interject "not affixed or attached firmly" into this claim term creates an irreconcilable ambiguity because it could be interpreted in one of two ways: (1) not affixed OR not attached firmly, or (2) not affixed firmly or not attached firmly. This ambiguous construction leads to a self-contradictory statement in which "not affixed" would be an acceptable construction, but "not attached firmly" would not. For all the reasons explained above, the second construction is simply not correct. Because of the ambiguity created by Dr. Feland's proposed construction, a POSITA would not adopt Dr. Feland's construction for these terms.

85. In light of the above, it is my opinion that a POSITA would fully understand the meaning of these claim terms based on the claim language and the specification of the Patents-in-Suit, and that therefore no construction of these claim terms is necessary.

C. Group C:

(i) "a first restrictor sleeve secured to said first end of said inner and said outer tubes" / "a first restrictor sleeve secured to said first end of said flexible inner tube and said flexible outer tube"

(ii) "a second restrictor sleeve secured to said second end of said inner and said outer tubes" / "a second restrictor sleeve secured to said second end of said flexible inner tube and said flexible outer tube"

86. As I stated in the Glancey Declaration, it is my opinion that these claim terms or phrases do not require a construction at least because they are easily understandable to a POSITA on their face, and also because each phrase is defined by the language of the claim itself. My opinions and analyses from the Glancey Declaration regarding this grouping of claim terms are hereby incorporated by reference in their entirety. Glancey Declaration at ¶¶ 54-57.

87. To be clear, my opinion is that upon taking into consideration the claims, specification and prosecution histories of the Patents-in-Suit, these claim terms are clear on their face to a POSITA. Based on my extensive experience in the field of mechanical engineering and fluid systems and hoses, a POSITA would know immediately what was being referred to by these claim phrases and certainly at the time of the claimed invention disclosed in the Patents-in-Suit.

88. A POSITA at the time of the invention would understand that a plain reading of these claim terms themselves simply describes either (1) *a first restrictor sleeve* secured to the first end of the inner and outer tubes, or (2) *a second restrictor sleeve* secured to the second end of the inner and outer tubes. The claims themselves as well as the specification both describe the claimed "restrictor sleeves" as simply a component or sleeve that serves to restrict the expansion of the inner tube – which is the ordinary meaning a POSITA would ascribe to this term. For example, Claim 5 of the '870 Patent states that "said first and second restrictor sleeves provide a gradual transition of the laterally outward expansion of said inner tube …"). And, the

specification of the Patents-in-Suit explain that "sleeve 27 [at the first end of the hose] permits the inner tube 14 to gradually expand" ('870 Patent at 11:33-45) and that "sleeve 26 [at the second end of the hose] permits the inner tube 14 to gradually expand" ('870 Patent at 11:4-14). In light of the clear language from the claims and the specification, it is my opinion that no further definition or construction is necessary – the meaning of these claim terms is clear on their face given their plain and unambiguous language.

89. I, therefore, do not believe these terms require any construction by the Court, given that they would be clear and well understood on their face to a POSITA.

90. Dr. Feland asserts that each of these claim terms should be construed to mean: "a device that restricts the expansion of the inner tube and ***is affixed or attached firmly so it cannot be removed*** from the [first/second] end of the [flexible] inner tube and the [first/second] end of the [flexible] outer tube." Feland Declaration at ¶ 98 (emphasis added). I disagree with Dr. Feland's constructions of these claim terms and the analysis he used to arrive at his constructions.

91. As an initial matter, there is nothing in the claim language, specification or prosecution histories of the Patents-in-Suit that mentions or requires Dr. Feland's above-emphasized proposed additional limitation, and Dr. Feland does not cite to anything from the intrinsic record requiring his proposed limitation. Dr. Feland therefore attempts to improperly interject the above limitation into the claim terms absent any indicia of inventor lexicography or disclaimer. As such, it is my opinion that a POSITA would not understand these claim terms to require the additional narrowing limitation that Dr. Feland seeks to introduce and include, nor are those concepts necessary to make the claimed invention. Put simply, there is no basis to add the aforementioned limitation to these easily understandable claim terms.

92. Dr. Feland's analysis to arrive at his proposed constructions is flawed for several reasons.

93. First, Dr. Feland once again asserts that "secured" needs to be construed because it "overlaps with 'couple.'" Feland Declaration at ¶ 93. For the reasons explained above, I disagree with Dr. Feland. Moreover, and as I also explained above, to the extent, these terms should be construed, they can and should be construed far less narrowly than what Dr. Feland proposes.

94. Second, Dr. Feland asserts that his proposed construction is the correct one because "there is nothing in the specification or the claims that teaches how a 'restrictor sleeve' can be 'removably connected' to the ends of the inner and outer tubes" and because there is "[n]othing in the specification or claims [that] suggest that the 'restrictor sleeve' can be 'removably connected' to the inner or outer tubes." Feland Declaration at ¶ 94. This analysis is completely flawed. The apparent lack of a teaching does not support Dr. Feland's proposal to import an extremely narrow limitation into the claim terms. Indeed, it is telling that Dr. Feland did not cite to a single instance from the claims, specification, or prosecution histories of the Patents-in-Suit that actually support his proposed constructions. More importantly and contrary to Dr. Feland's assertion, a POSITA, reading the claims, specification and prosecution histories of the Patents-in-Suit would readily know how to build a removable restrictor sleeve. For example, a POSITA would know that he or she could use a threaded connection or a removable clamp (like the one identified above) to attach the restrictor sleeve to the ends of the inner and outer tubes, as both methods of attachments were well known to a POSITA at the time of the invention.

95. Third, to support his proposed constructions, Dr. Feland simply recites the claim language and in conclusory fashion states that somehow supports his narrow constructions. Feland Declaration at ¶¶ 95-96. This is just Dr. Feland's unsupported *ipse dixit*. Indeed, nowhere in the claims does it state or even suggest that "secured" means "affixed or attached firmly so it cannot be removed." To the contrary, and as I have explained above, a POSITA would know and believe the opposite – that "secured" or securing can involve either permanent or non-permanent means of attachments. That is, a POSITA would readily understand that to firmly attach, fasten, or fix one object to another simply means the attachment is firm or tight – it does not mean the objects are attached such that they cannot be removed. This is supported by the fact that the claims and specification repeatedly use the word "secure" to describe removable connections. *See*, *e.g.* '870 Patent at 10:1-4, 10:11-12; 12:219-33; 16:7-8.

96. Fourth, Dr. Feland again relies on the same dictionary definitions of "secure" to support his narrow constructions. Feland Declaration at ¶ 97. For the reasons explained above, none of those definitions support Dr. Feland's proposed constructions at least because the definitions themselves are not so narrow and in fact are much broader.

97. Lastly, Dr. Feland attempts to interject ambiguity as to what the claimed "restrictor sleeves" are by proposing disingenuous hypotheticals. He uses this alleged ambiguity as a spring board to assert his proposed narrow constructions. Feland Declaration at ¶ 92. I disagree with Dr. Feland that the claimed "restrictor sleeves" need to be construed. As I stated in the Glancey Declaration, the claims and specification make clear what the restrictor sleeves are and what they do: the "first and second restrictor sleeves provide a gradual transition of the laterally outward expansion of [the] inner tube when there is an increase in pressurized liquid within [the] inner tube interior between [the] first coupler and [the] second coupler." '870 Patent

at Claim 5; *see also id.* at Figs. 7 (element 26) and 8 (element 27); 11:9-19. Put simply, the claims and specification make clear that the purpose of the restrictor sleeves is to limit the lateral expansion of the inner tube when pressurized water is introduced into the hose in order to prevent the inner tube from rupturing. Dr. Feland fails to refute this.

98. In light of the above, it is my opinion that a POSITA would fully understand the meaning of these claim terms based on the claim language and the specification of the Patents-in-Suit, and that therefore no construction of these claim terms is necessary.

D. Group D:

(i) "a first securing device securing said first restrictor sleeve, said outer tube, and said inner tube to said first coupler" / "a first securing device securing said first restrictor sleeve, said flexible outer tube, and said flexible inner tube to said first coupler"

(ii) "a second securing device securing said another expansion restrictor sleeve, said outer tube and said inner tube to said second coupler" / "a second securing device securing said second expansion restrictor sleeve, said flexible outer tube and said flexible inner tube to said second coupler"

99. As I stated in the Glancey Declaration, it is my opinion that these claim terms or phrases do not require a construction at least because they are easily understandable to a POSITA on their face, and also because each phrase is defined by the language of the claim itself. My opinions and analyses from the Glancey Declaration regarding this grouping of claim terms are hereby incorporated by reference in their entirety. Glancey Declaration at ¶¶ 58-74.

100. To be clear, my opinion is that upon taking into consideration the claims, specification and prosecution histories of the Patents-in-Suit, these claim terms are clear on their face to a POSITA. Based on my extensive experience in the field of mechanical engineering and fluid systems and hoses, a POSITA would know immediately what was being referred to by these claim phrases and certainly at the time of the claimed invention disclosed in the Patents-in-Suit.

101. As I stated in the Glancey Declaration, my opinions regarding these claim terms are that (1) they do not do not require a construction (*see* Glancey Declaration at ¶¶ 60-61), (2) they are not subject to 35 U.S.C. § 112, sixth paragraph (i.e., they are not written in means-plus-function form, and therefore they should not be construed pursuant to 35 U.S.C. § 112, sixth paragraph) (*see* Glancey Declaration at ¶¶ 62-69), and (3) they are not indefinite under 35 U.S.C. § 112, second paragraph (i.e. the claims set forth the subject matter that the inventor regards as the invention) (*see* Glancey Declaration at ¶¶ 70-74). Glancey Declaration at ¶¶ 58-74.

102. Notably, as I stated in the Glancey Declaration and contrary to Dr. Feland's assertions, a POSITA at the time of the invention would understand that a plain reading of these claim terms themselves simply describes either (1) *a first securing device* that secures the first restrictor sleeve, the outer tube, and the inner tube to the first coupler, or (2) *a second securing device* that secures the second restrictor sleeve, the outer tube and the inner tube to the second coupler. The claims themselves as well as the specification both describe the claimed "securing devices" as simply any device that serves to attach the corresponding (i.e., first or second) restrictor sleeve, the outer tube, and the inner tube to the corresponding (i.e., first or second) coupler – nothing more. For example, Claim 7 of the '870 Patent states that the "first securing device" simply "secur[es] said first restrictor sleeve, said outer tube, and said inner tube to said first coupler," and that the "second securing device" simply "secur[es] said another expansion restrictor sleeve, said outer tube and said inner tube to said second coupler." And, the specification of the Patents-in-Suit states that "securing device 40 encompasses the outer sleeve 27, the outer tube 12, and the inner tube 14 and secures these elements to the tubular extension 36 [of the coupler 18]" ('870 Patent at 11:31-33) and that "securing device 34 encompasses the outer sleeve 26, the outer tube 12, and the inner tube 14 and secures these elements to the tubular

extension 34 [of the coupler 16]" ('870 Patent at 10:65-67). Importantly, the specification specifically contemplates this broad scope by explaining that various *other* types of devices may be used to secure the restrictor sleeve, the outer tube, and the inner tube to the couplers and thus it would be understood by a POSITA that the claimed "securing devices" could be any known securing device. *Id.* at 11:13-16 ("Other types of connections, such as clamping and swaging can also be employed to secure the male coupler to the inner tube 14, the outer tube 12, and the sleeve 26."); *id.* at 11:45-47 ("Other types of connections, such as clamping and swaging can also be employed to secure the female coupler to the inner tube 14, the outer tube 12, and the sleeve 27.").

103. In response, Dr. Feland first asserts that each of these claim terms should be construed to mean: "a device ***[1] encompassing and [2] affixing or attaching firmly*** the [first/second] restrictor sleeve, ***[3] the [first/second] end*** of the outer tube, and ***[4] the [first/second] end*** of the inner tube to the [first/second] coupler ***[5] so they cannot be removed***." Feland Declaration at ¶ 107 (emphasis added). I disagree with Dr. Feland's proposed constructions.

104. As initial matter, Dr. Feland's proposed constructions attempt to improperly interject no fewer than five additional limitations into these easily understandable claim terms. Even more egregiously, Dr. Feland fails to cite to any evidence from the claims, specification or file histories of the Patents-in-Suit to support his constructions. This is because there is no intrinsic evidence that could possibly support his extremely narrow construction. I, therefore, disagree that a POSITA would have understood these claim terms to include such narrow limitations because such constructions clearly depart from the plain language of the claims, are

not supported by the specification, and are not otherwise required by inventor lexicography or disavowal, nor are these concepts necessary to make the claimed invention.

105. To support his proposed constructions, Dr. Feland only points to the dictionary definitions of "securing" – like he did with respect to the Group A-C claim terms. Feland Declaration at ¶ 106. For the reasons explained above, none of those definitions support Dr. Feland's proposed constructions at least because the definitions themselves are not so narrow and in fact are much broader. Moreover, and as also explained above, the Patents-in-Suit all use the word "secure" to refer to removable connections – which directly contradicts Dr. Feland's proposed construction requiring "securing" to mean "affixing or attaching firmly … so they cannot be removed."

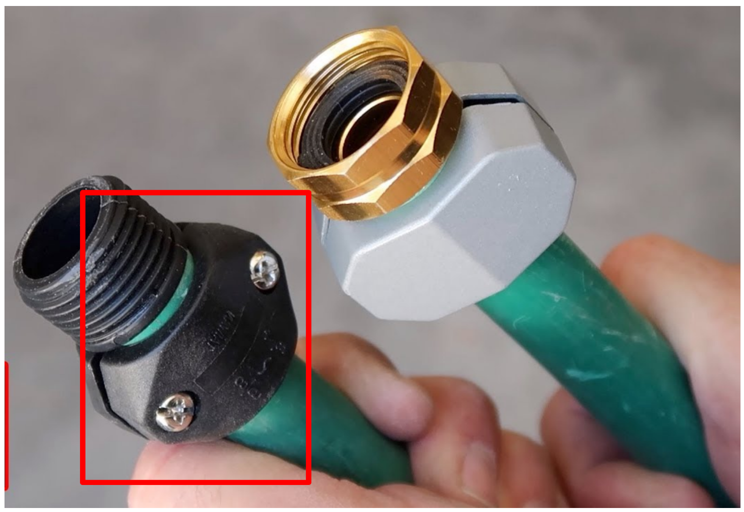
106. Next, Dr. Feland devotes exactly one paragraph as to why he believes the claimed "securing device" is a nonce term that should be construed pursuant to 35 U.S.C. § 112, sixth paragraph. Feland Declaration at ¶ 106. Dr. Feland states the "claims reciting a 'securing device' do not provide any structure besides a 'device' that is used to 'secure' the 'inner tube,' the 'outer tube,' and the 'restrictor sleeve' to the 'couplers.'" *Id.* Notably, Dr. Feland failed to address any of my analysis from the Glancey Declaration explaining that, based on my experience in the field, a POSITA reading the claims and the specification would readily understand the claim term "securing device" to be any type of *structural element (or elements)* that can be used to secure or connect a restrictor sleeve, an outer tube, and an inner tube to a coupler of the hose. I hereby incorporate by reference herein my entire analysis regarding this point from the Glancey Declaration, which Dr. Feland failed to address. Glancey Declaration at ¶¶ 62-69.

107. Lastly, Dr. Feland asserts that if construed under 35 U.S.C. § 112, sixth paragraph, “securing device” must be construed to be only the ring labeled “34” in FIG. 7 and labeled “40” in FIG. 8. Feland Declaration at ¶ 119. However, Dr. Feland goes one step further when he concludes that this means that “securing device” must be construed as a “ring, of a width roughly one fifth of the width of the threaded portion of the female coupler, encompassing and affixing or attaching firmly the restrictor sleeves, the ends of the outer tube, and the ends of the inner tube to the couplers so they cannot be removed.” *Id.* I disagree with Dr. Feland on this point for several reasons.

108. First, as an initial matter, Dr. Feland is once again attempting to improperly import the same five limitations into this construction as explained above (*see* paragraph 103). And, he once again does so without providing any support from the claims, specification or the prosecution histories of the Patents-in-Suit.

109. Second, Dr. Feland attempts to improperly limit the claimed “securing device” to the exact embodiment disclosed in the specification. Feland Declaration at ¶¶ 108-119. To support his position, Dr. Feland asserts that the specification only discloses one embodiment and a POSITA would not otherwise know how to make any other type of “securing device” to perform the claimed function. *Id.* To further support his flawed position, Dr. Feland attempts to discredit my assertion that the “securing device” could be any known securing structure, including those expressly disclosed in the specification: “[o]ther types of connections, such as clamping and swaging [that] can also be employed to secure the [] coupler to the inner tube 14, the outer tube 12, and the sleeve.” ’870 Patent at 10:65-67; 11:31-33. Dr. Feland goes on to (incorrectly) explain how each of my proposed securing structures would not work with the claimed hose. Feland Declaration at ¶¶ 99-105, 111.

110. Putting aside that I generally disagree with Dr. Feland's analysis, I highlight a couple of reasons why Dr. Feland's analysis is completely flawed. First, Dr. Feland fails to acknowledge that a POSITA would have easily been able to implement a clamp using screws or nuts and bolts to secure the restrictor sleeve, the outer tube and the inner tube to the couplers. For example, a POSITA would have easily known how to use a clamp like the one shown below (identified by the red box):



I note that the clamp shown above utilizes two screws to secure the two-piece clamp to the hose end assembly.

111. As another example, a POSITA would have easily known how to use threaded connectors to achieve the claimed invention. Indeed, threaded connectors have been standardized and used in connection with garden hoses since the 1960s. Dr. Feland does not assert otherwise, but only that if the inventors contemplated using threaded connectors, they would have disclosed them. That, however, does not negate the fact that a POSITA would have easily known how to use threaded connectors to achieve the claimed invention.

112. I therefore stand by my original statement that a POSITA would have known and appreciated that there are many standard ways to secure hose end assemblies (like the claimed

hose end assembly) that could have easily been implemented with the claimed hose. As such, I disagree with Dr. Feland's narrow construction of the "securing device" claim terms. Thus, if "securing device" is determined to be a means-plus-function limitation under 35 U.S.C. § 112, sixth paragraph, my opinion is that a POSITA would understand that its corresponding structure would be construed to be: "at least securing rings 34 and 40 and any appropriate and well-known securing devices, known at the time of the claimed invention." Such known devices can at least be clamps (including the clamp shown above) and threaded connectors. I note that clamping is specifically contemplated in the specification and so for that reason alone Dr. Feland's proposed construction (which excludes clamps) is far too narrow.

I hereby certify that the facts set forth above are true and correct to the best of my personal knowledge, information, and belief, subject to the penalty of perjury, and are offered to a reasonable degree of engineering certainty.

Dated: March 4, 2024 By: ______________________
JAMES L. GLANCEY

JAMES L. GLANCEY
LICENSE
No. 19743
DELAWARE
PROFESSIONAL ENGINEER

Exhibit A

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF OHIO
EASTERN DIVISION

TELEBRANDS CORPORATION, Plaintiff, v. WINSTON PRODUCTS LLC, Defendant.	Case No. 1:23-cv-00631-BMB Judge Bridget Meehan Brennan

DECLARATION OF DR. JAMES L. GLANCEY REGARDING CLAIM CONSTRUCTION OF U.S. PATENT NOS. 10,174,870; 10,890,278; AND 11,608,915

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I, James L. Glancey, hereby declare the following:

I. INTRODUCTION

1. My name is Dr. James L. Glancey. I have been asked to submit this declaration on behalf of Telebrands Corporation ("Telebrands") in connection with the above lawsuit against Winston Products, LLC ("Winston Products"). Specifically, I have been retained as an independent technical expert consultant by Telebrands to provide my opinions regarding the technology of U.S. Patent Nos. 10,174,870 ("the '870 Patent"); 10,890,278 ("the '278 Patent"); and 11,608,915 ("the '915 Patent") (collectively, the "Patents-in-Suit"), the knowledge that a person of ordinary skill in the art ("POSITA") working in that field of technology would be expected to have, how a person of ordinary skill in the art would have understood specific claim terms recited in the Patents-in-Suit, and whether some of those terms should be found indefinite.

2. This declaration sets forth the opinions that I have formed based on the information available to me as of the date below. The opinions and facts set forth in this declaration are based upon my analysis of the Patents-in-Suit and their claims, the additional materials I have considered as set forth below, the state of the art at the time of the invention, as well as my knowledge and extensive experience in this field.

3. My analysis of the materials submitted in this proceeding is ongoing and I will continue to review any new materials that are provided. This declaration is indicative of only those opinions that I have formed to date and that are set forth herein. I reserve the right to amend, revise, and/or supplement my opinions stated herein based on any new information that may become available to me or my continuing analysis of the materials already provided.

4. I am not currently and have not at any time in the past been an employee of Telebrands. I have no financial interest in Telebrands outside of assisting Telebrands as an expert in this and any related matters.

5. I am being compensated at my normal consulting hourly rate. My compensation is not in any way dependent on the outcome of any matter or the opinions stated herein.

II. PROFESSIONAL BACKGROUND AND QUALIFICATIONS

6. My opinions stated in this declaration are based on my own personal knowledge and professional experience and judgment. In forming my opinions, I have relied on my knowledge and experience in designing, developing, researching, and teaching the technology discussed and referenced in this declaration.

7. My qualifications for forming the opinions in this report are summarized herein and explained in more detail in my curriculum vitae ("CV"), attached as Exhibit A.

8. As detailed in my CV, I have extensive experience as a trained and licensed mechanical engineer in the design and development of various mechanical systems and devices, including systems that implement hoses, with a career spanning over 30 years in this field. I have conducted research in the areas of complex mechanical systems, fluid systems and fluid dynamics, and I have taught courses on complex mechanical and machine designs, many of which require the use of hoses and tubing and a comprehensive understanding of fluid dynamics.

9. I am currently the principal and owner of Mechanical Design and Forensic Analysis LLC in Middletown, Delaware, and I have held these positions in the company for over 30 years.

10. I am also currently a Professor in both the Mechanical Engineering Department & the College of Agriculture and Natural Resources at the University of Delaware, and have held those positions since 2012. Prior to that, from 1991 to 2012, I was an Assistant then Associate Professor before being promoted to Full Professor with tenure.

11. I was also a partner at Structural Mechanics Associates in Haverford, Pennsylvania for seven years from 2012 to 2019 where I worked on projects including the design and failure of mechanical systems and fluid power systems.

12. I received a Bachelor of Science degree in Biosystems Engineering from the University of Delaware in 1985, and a Master of Science and Ph.D. in Engineering from the University of California at Davis in 1987 and 1991, respectively.

13. I am a Licensed Professional Mechanical Engineer (26 years; DE License No. 19743) and have testified at trial and in depositions over 50 times. In my practice, I have been recognized as an engineering expert in both State and Federal courts 17 times in the U.S. and in St. Croix, Virgin Islands. In total, I have been hired as an engineering expert for products liability litigation and patent infringement matters more than 200 times over the past 25 years.

14. In 1991 after completing my Ph.D. dissertation at the University of California at Davis and accepting an engineering faculty position at the University of Delaware, I also began operating my family's farm, owning and raising lean beef cattle breeds and growing grain crops on about 160 acres for about 10 years. In this capacity, I used and maintained a variety of power and shop tools and large mobile hydraulic equipment and machinery to plant and harvest grain crops. Among other things, these responsibilities required me to design and fabricate fluid power hoses with tooling specific to hose manufacturing. Subsequently, I purchased my own farm in Delaware which is equipped with both a metal shop and wood working shop with lifts, and a variety of pieces of large farm and construction equipment and machinery that I own, operate, and maintain. This maintenance required me to design and manufacture high pressure hoses for some of this equipment. And this facility also contains a laboratory, a metal shop for product examinations and testing as well as for prototype fabrication, and a hydraulic test stand

and hydraulic system fabrication equipment that requires fittings and hoses used for prototyping the designs of fluid systems.

15. My academic experience includes serving as an Assistant Professor, Associate Professor, and Full Professor of Machine Design and Development in the Mechanical Engineering Department at the University of Delaware; as well as an appointment in the College of Agriculture and Natural Resources as a Full Professor in the Delaware Cooperative Extension as an Engineering Specialist. In this capacity, I provide a variety of services using my technical knowledge and design expertise for businesses and governments in the Mid-Atlantic region of the U.S. My applied work, in part, focuses on the design and development of pneumatic and hydraulic systems for manufacturing automation and off-highway equipment for agriculture and construction. This work required the design, specification, and fabrication of hoses and tubes for many of these systems. My work also involves the design of water supply systems for irrigation which require the use of pipes and/or hoses as part of the systems. These examples are further outlined in my CV.

16. As a Full Professor with tenure in Mechanical Engineering, my broader responsibilities include teaching, research, outreach and service often in the form of independent consulting for various industries and for litigation matters. I have taught each of the upper-level Mechanical and Machine Design Courses in the Department of Mechanical Engineering, as well as co-taught the Capstone Design Course that annually serves over 200 students in Mechanical Engineering, Biomedical Engineering, Civil Engineering, Environmental Engineering, and Electrical Engineering. In this capacity, I introduce students to the disciplines of design science, product and process development, design for manufacture, and failure analysis methods including Fault Tree Analysis and Failure Modes and Effects Analysis (FMEA). I also have led

the Graduate Level Industry Partnership Program in Mechanical Engineering, which facilitates industry-sponsored design and modeling projects for Mechanical Engineering graduate students to pursue for academic credit. Collectively, these courses use industry-sponsored design projects, and have served various design needs for over 200 companies in the U.S. In this capacity, I also introduce students to concepts of patents generally, patent infringement, and licensing of intellectual property. These projects often require the design of fluid systems – for example fluid metering systems to produce a precise amount of fluid – for several different industries including medical devices and the precision manufacturing of materials.

17. In addition, my experience and credentials include an appointment in the University of Delaware Center for Composite Materials, an internationally recognized, interdisciplinary center of excellence for composites research and education. My experience in this capacity is threefold: 1) automation of VARTM (Vacuum Assisted Resin Transfer Molding) infusion processes, 2) new product development using composite materials, and 3) rapid preform formation for near net shape structural components for automotive applications. Notably, the automation of the VARTM processes included the precise control of liquid resin flow with a composite fabric preform using a system of valves, hoses and tubes.

18. Based on my research at the University of Delaware, I am an inventor on one U.S. patent related to vegetable harvesting, and three U.S. patents related to composite materials manufacturing and automation. I have also applied for six provisional patents and have several patent applications submitted to the U.S. Patent and Trademark Office. Several of these applications pertain to the use of composites in hand and power tool design, and mechanical devices. Other patents and patent applications pertain specifically to the control of fluid flow for

the purposes of fully infusing a composite preform without forming any voids. And, these novel inventions relied on the use of hoses for the purpose of conveying a fluid.

19. In my professional practice, I also regularly consult for companies and law firms to assist them with various types of mechanical design and manufacturing challenges and litigation matters for products ranging from medical devices and manufacturing equipment and processes to consumer products to industrial and farm machinery. Some of these matters involve characterizing the fluid flow in such products as a jet ski, a fluid metering system for reagents of a medical analytical instrument, failed hoses used for resin transfer, and large flat hoses for industrial applications.

20. I have been hired as a design engineer and consultant for multiple major U.S. companies and government agencies including: Monsanto, Galena, MD (2x); the DuPont Company, Wilmington, Delaware (3x); Advance Materials Technologies, Wilmington, Delaware; Siemens Healthcare Diagnostics, Newark, Delaware (10x); Northrup Grumman (formerly ATK/Thiokol), Elkton, Maryland; Kraft Foods, Dover, Delaware (3x); the State of Delaware (3x); the Town of Middletown, Delaware (6x); the Town of Odessa, Delaware; the Town of Bridgeville, Delaware; Baltimore Tool Works, Inc. (2x); Duffield Engineering Associates, Wilmington, Delaware; the Consumer Union (Consumer Reports Magazine), Yonkers, New York (3x); and Dogfish Head Brewery, Milton, Delaware. For companies like Siemens, AMT, and Dogfish Head, their projects involved fluid handling and metering systems (including hoses) for the manufacture of their fluid products.

21. My professional academic accomplishments include over 50 refereed engineering journal articles and refereed proceedings. I served for eight years as Associate Editor for two premier engineering journals and have served as a reviewer for over 20

engineering and scientific journals in the U.S. and abroad. I have also published over 75 conference papers and given 190 invited and/or conference presentations in the U.S., Canada, and Europe.

22. I have received several academic awards as well as industry awards since being promoted to Associate and then Full Professor at the University of Delaware. This includes being inducted into the University of Delaware's Mentor's Circle in 2001, which is an award given to faculty who have been nominated by students and faculty for their accomplishments in mentoring, teaching, and advising undergraduate and graduate students. I also received the George M. Worrilow Award, the highest honor awarded by the CANR given to an alumnus of the University of Delaware who has demonstrated outstanding service to agriculture. In 2014, I received the Delaware Farm Bureau Distinguished Service to Agriculture Award, given to recognizesignificant contributions to agriculture in the mid-Atlantic region; I was the first faculty member at the University of Delaware to ever win this award. I, along with Delaware Governor, Jack Markell, Secretary of Environmental Control for the state of Delaware, Collin O'Mara; Secretary of Agriculture for the State of Delaware, Edwin Kee; Mayor of Middletown, Delaware, Kenneth Branner; and President of Artesian Water, Dian Taylor, received the Water Resources Associationof the Delaware River Basin's Government Award for the first use of highly treated municipal wastewater for irrigating agricultural crops on an as-need basis in the mid-Atlantic region.

23. As a peer reviewer of journal articles being considered for publication, I received the American Society of Agricultural and Biological Engineers Outstanding reviewer award in 2012. I was also nominated and selected to serve two four-year terms as Associate Editor for the two journals published by the American Society of Agricultural and Biological

Engineers. I have also served as a peer reviewer for 20 different journals and other publications including research work in Mechanical and Agricultural Engineering, Composite Materials, and Agricultural Production and Sciences. Journals I have published in and been a reviewer for include the Transactions of the American Society of Mechanical Engineers, the Transactions of Society of Automotive Engineering, and the Journal of the American Institute of Aeronautics and Astronautics.

24. Through the Delaware Cooperative Extension Service, I have cooperated with and provided engineering services and guidance to farm businesses on over 50 on-farm engineering projects in Delaware, Maryland, Pennsylvania, and New Jersey. In this capacity and as outlined in my Curriculum Vitae, I have made over 70 invited presentations at Cooperative Extension Service meetings or other local conferences and meetings. These presentations include topics pertaining to the proper and safe operation of mobile and off-road equipment, and the development and care of hydraulic systems and components including but not limited to hoses for systems involving irrigation, sanitizing and cleaning, and fluid power transmission.

25. My experience of over 30 years in academic and practical situations as well as my hands-on experience has given me an extensive understanding of the technology set forth in the Patents-in-Suit.

III. MATERIALS AND OTHER INFORMATION CONSIDERED

26. In preparation for this declaration, I have considered the specification, claims, and file history of each of the Patents-in-Suit. I have reviewed Telebrands' Preliminary Proposed Constructions and Supporting Evidence, Winston Products' Preliminary Proposed Constructions and Supporting Evidence, and the other materials mentioned herein. In addition, my opinions are also based on my education, training, experience, and knowledge in the relevant field.

27. I reserve the right to supplement, amend, or modify my opinions based on any new information, documents, and/or arguments that are made available to me after the submission of this declaration.

28. To the extent that additional information is presented and becomes available to me during these proceedings, including the briefing and argument related to claim construction and/or any opposing expert opinions, I reserve the right to amend, supplement, or modify my opinions as appropriate.

IV. SUMMARY OF OPINIONS

29. Based on my analysis of the materials and information I considered in connection with this declaration, it is my opinion that Winston Products' proposed constructions attempt to improperly import limitations from the specification into the claims and/or add unnecessary requirements that do not appear to be supported by the claim language, the specification or the prosecution histories. It is apparent to me, and it would have been apparent to a POSITA at the time of the invention (i.e., 2011) that none of the below identified claim terms require a construction at least because each claim term is easily understandable on its face, and would have been known and understood by a POSITA at the time of the invention.

30. Further, it is my opinion that the various claim terms reciting a "securing device" are not subject to pre America Invents Act 35 U.S.C. § 112, paragraph 6, and even if they are, they are not indefinite because the specification of the Patents-in-Suit disclose adequate structure corresponding to the claimed function.

V. UNDERSTANDING OF PATENT LAW

31. I am a technical expert and do not offer any legal opinions or interpretations of the law. However, counsel has informed me as to certain legal principles regarding patent claim

construction and related matters under United States patent law, as described below, which I have applied in performing my analysis and arriving at my technical opinions in this matter.

32. I have been informed that a U.S. patent includes a specification that describes examples of the invention(s) invented by the inventor(s), and one or more claims that define the scope of the subject matter protected by the patent, and over which the patentee has exclusive property rights.

33. I have been informed by counsel that the general rule of claim construction is that claim terms are generally given their plain and ordinary meaning as understood by a POSITA at the time of the invention, in light of the specification and prosecution history. I have also been informed by counsel that there are only two exceptions to this general rule: (1) when a patentee sets out a definition and acts as his own lexicographer, or (2) when the patentee disavows the full scope of a claim term either in the specification or during prosecution. When the patentee acts as his own lexicographer, any special definition given to a word must be clearly set forth in the specification. Disavowal requires that either the specification or the prosecution history show that the patentee clearly, unambiguously, and unmistakably disclaimed or disavowed certain claim scope during prosecution in order to obtain claim allowance.

34. I have been informed that, in construing claim terms, the Court looks first to the intrinsic evidence of record, which includes the claims themselves, the remainder of the specification and the prosecution history of the patent(s). I further understand that the Court may also consider extrinsic evidence, which includes expert testimony, dictionaries, and learned treatises.

35. I have also been informed by counsel about the legal principles regarding 35 U.S.C. § 112, paragraph 6 – the statute that governs what is referred to as means-plus-function

limitations. Specifically, I have been informed that means-plus-function claim terms governed by 35 U.S.C. § 112, paragraph 6, are limited to only the structure, materials, or acts described in the specification as corresponding to the claimed function and equivalents thereof. I also understand that the lack of the term "means" in a claim limitation creates a rebuttable presumption that the claim limitation is not a means-plus-function term governed by 35 U.S.C. § 112, paragraph 6. I further understand that this presumption can be rebutted if it can be established that the claim term fails to recite sufficiently definite structure or recites function without reciting sufficient structure for performing that function. This determination must be made by examining the claim language as a whole. I also understand that generic terms such as mechanism, element, member, component, or other nonce words that reflect nothing more than verbal constructs may be used in a way that is effectively the same as the word "means." The standard in determining whether a specific claim limitation is subject to 35 U.S.C. § 112, paragraph 6, is whether the words of the claim are understood by a POSITA to have sufficiently definite meaning as the name for structure.

36. If it is established that 35 U.S.C. § 112, paragraph 6, applies to a specific claim limitation, construing the claim limitation is a two-step process. First, the function of the means-plus-function limitation is determined. Second, the structure disclosed in the specification corresponding to the function and its equivalents is determined. The structure disclosed in the specification is the "corresponding" structure only if the specification or prosecution history clearly links or associates that structure to the function recited in the claim. The corresponding structure must include all structure that performs the recited function. If the specification or prosecution history does not disclose adequate corresponding structure, the claim is indefinite under 35 U.S.C. § 112, paragraph 2.

VI. PERSON OF ORDINARY SKILL IN THE ART

37. I understand that there are various factors relevant to determining the level of ordinary skill in the pertinent art, including the educational level of active workers in the field at the time of the alleged invention, the sophistication of the technology, the type of problems encountered in the art, the prior art solutions to those problems, and the rapidity with which innovations are made.

38. In determining the characteristics of a hypothetical POSITA of the Patents-in-Suit at the time of the invention, I considered several things, including the type of problems encountered in this field, and the rapidity with which innovations were made. I also considered the sophistication of the technology involved, and the educational background and experience of those actively working in the field, and the level of education that would be necessary to understand the Patents-in-Suit. Finally, I placed myself back in the relevant period of time (i.e., 2011) and considered the state of the art and the level of skill of the persons working in this field at that time.

39. Based on the materials I have considered, my own personal knowledge and experience, and the level of skill required to design and build an expandable and contractible hose, I have come to the conclusion that the characteristics of a POSITA in connection with the Patents-in-Suit would hold a Bachelor's Degree in Mechanical Engineering or a closely related technical field and would have at least two years of experience in the manufacture, design and/or the application and use of hoses for various types of fluids. This hypothetical person would be capable of performing various design tasks and would understand the basic mechanical and fluid features and operation of expandable and contractible hoses; this hypothetical person would also have at least a basic knowledge of fluid mechanics, solid mechanics, and materials science and

engineering as they relate to hoses and how hoses generally function to convey fluids from one place to another.

40. I was at least a POSITA as of the priority date of the Patents-in-Suit (i.e., 2011).

41. My opinions concerning the claim terms of the Patents-in-Suit are from the perspective of a POSITA, as set forth above, at the time of the invention.

VII. TECHNOLOGY BACKGROUND

42. The Patents-in-Suit are generally directed to an expandable and contractible hose that automatically expands to an extended state when pressurized water is introduced into the hose and automatically contracts back to a contracted state when the pressurized water within the hose is subsequently released. ’870 Patent at 1:39-43.[1]

VIII. OPINIONS CONCERNING CLAIM CONSTRUCTION

43. Each of the below claim terms have been identified by Winston Products as needing to be construed. As explained below, it is my opinion that none of the below claim terms require a construction at least because they are unambiguous and would have all been easily understood by a POSITA at the time of the invention. It is further my opinion that, for all the identified claim terms, the constructions offered by Winston Products contain limitations that do not appear to be justified by the language of the claims or the specification.

44. The below claim terms have been grouped together to the extent they incorporate common subject matter or involve similar issues.

[1] Unless otherwise noted, I cite to the ’870 Patent specification throughout this declaration when referring to the Patents-in-Suit because the specifications of the three Patents-in-Suit are substantively identical.

A. "secured"

"to couple"

"coupled to"

45. It is my opinion that the terms "secured," "to couple," and "coupled to" are unambiguous and well-known terms that are easily understood on their face and, therefore, do not require a construction.

46. I understand that Winston Products asserts that these claim terms should be construed as follows:

- "secured" means "permanently attached";
- "to couple" means "to removably connect"; and
- "coupled to" means "removably connected to."

47. All of Winston Products' proposed constructions for these three terms suffer from the same problem – they all attempt to improperly interject extraneous characterizations of the type of attachment or connection, i.e., ***permanently*** attached or ***removably*** connected, into the claim terms. I disagree that a POSITA would have understood these claim terms to include such narrow limitations because such constructions clearly depart from the plain language of the claims, are not supported by the specification, and are not otherwise required by inventor lexicography or disavowal, nor are those concepts necessary to make the claimed invention.

48. Notably, the words "permanently" and "removably" do not appear anywhere in the claims, the specification, or prosecution histories. Nor is there any reason, in my opinion, that a POSITA at the time of the invention would narrow the meaning of these well understood words as Winston Products suggests. Indeed, Webster's New World Dictionary and Thesaurus, Second Edition, defines the word "secure" to mean "to fasten" or "tighten" and defines the word

"coupling" to mean "joining together." *See* Exhibit B, attached hereto, at 4 (Webster's New World Dictionary and Thesaurus, Second Edition, 2013 ("Webster's"), definition of "secure"); *id.* at 3 (Webster's definition of "coupling"). Notably, these definitions do not state or suggest that "secure" means to ***permanently*** fasten, or that "coupling" means to ***removably*** join together. Indeed, a POSITA would have understood the exact opposite of what Winston Products proposes – that coupling or securing can involve either permanent or non-permanent connections. It is my opinion that there is nothing in the claims, specification or file histories that would require these claim terms to be limited as Winston Products contends, and a POSITA would not read such narrow limitations into these claim terms.

49. In light of the above, it is my opinion that a POSITA at the time of the invention would have easily understood these well-known terms based on the claim language and the specification of the Patents-in-Suit and, importantly, would not have understood them to be limited as Winston Products proposes. As such, it is my opinion that no construction of these terms is necessary.

B. "said inner and outer tubes unsecured between said first and second ends so that said outer tube is not held in frictional contact with said inner tube so that said outer tube can move freely along said inner tube"

"said inner tube is unsecured to said outer tube between said first and second ends so that said outer tube can move freely over said inner tube"

"said flexible inner tube unsecured to said flexible outer tube between said first and second ends so that said flexible outer tube can move freely over said flexible inner tube"

50. It is my opinion that these claim terms or phrases do not require a construction at least because they are easily understandable to a POSITA on their face, and also because each phrase is defined by the language of the claim itself.

51. A POSITA at the time of the invention would understand that a plain reading of these claim terms themselves simply describes two inner and outer tubes that are not attached to each other except at their respective first and second ends so that the outer tube can move freely along the inner tube – nothing more. That is, no further definition or construction of these terms is necessary because the meaning of these claim terms are clear on their face given their plain and unambiguous language. The specification also supports this clear understanding. Notably, the specification states that the "outer tube is unattached, unconnected, unbonded, and unsecured to the inner tube along the entire length of the inner tube, between the first end and the second end, so that the outer tube can move freely with respect to the inner tube along the entire length of the inner tube between the first end and the second end." '870 Patent at 7:10-16; *see also id.* at 1:47-53 ("The hose is comprised of an elastic inner tube and a separate and distinct non-elastic outer tube positioned around the circumference of the inner tube and attached and connected to the inner tube only at both ends and is separated, unattached[,] unbonded and unconnected from the inner tube along the entire length of the hose between the first end and the second end."); 9:1-9, 12:1-33, and 12:45-13:27.

52. I understand that Winston Products asserts that each of these claim terms should be construed to mean: "the inner and outer tubes are not ***[1] permanently*** attached together ***[2] except at the first coupler and the second coupler***, ***[3] so as to allow the inner and outer tubes to move relative to each other between*** the couplers ***[4] when the hose expands or contracts***." (emphasis added). This proposed construction adds no fewer than four unnecessary limitations absent any indicia of inventor lexicography or disclaimer. In fact, Winston Products' proposed construction appears to entirely rewrite the claim, requiring the inner and outer tubes to be "permanently" attached at the "couplers" so as to allow the inner and outer tubes to "move

relative to each other between the couplers" "when the hose expands or contracts." But there is nothing in the claim language that mentions or requires *any* of these proposed additional limitations. Indeed, it is my opinion that a POSITA would not understand these claim terms to require any of these four additional narrowing limitations that Winston Products seeks to inappropriately read into the claims, nor are any of those concepts necessary to make the claimed invention. Moreover, it is my opinion that the introduction of the last two limitations ("to allow the inner and outer tubes to move relative to each other between the couplers" and "when the hose expands or contracts") unnecessarily add ambiguity to these otherwise easily understandable claim terms. There is no basis to add any of these limitations to these -claim terms.

53. In light of the above, it is my opinion that a POSITA would fully understand the meaning of these claim terms based on the claim language and the specification of the Patents-in-Suit, and that therefore no construction of these claim terms is necessary.

C. (i) "a first restrictor sleeve secured to said first end of said inner and said outer tubes" / "a first restrictor sleeve secured to said first end of said flexible inner tube and said flexible outer tube"

(ii) "a second restrictor sleeve secured to said second end of said inner and said outer tubes" / "a second restrictor sleeve secured to said second end of said flexible inner tube and said flexible outer tube"

54. It is my opinion that these claim terms or phrases do not require a construction at least because they are easily understandable to a POSITA on their face, and also because each phrase is defined by the language of the claim itself.

55. A POSITA at the time of the invention would understand that a plain reading of these claim terms themselves simply describes either (1) *a first restrictor sleeve* secured to the first end of the inner and outer tubes, or (2) *a second restrictor sleeve* secured to the second end of the inner and outer tubes. The claims themselves as well as the specification both describe the

claimed “restrictor sleeves” as simply a component or sleeve that serves to restrict the expansion of the inner tube – which is the ordinary meaning a POSITA would ascribe to this term. For example, Claim 5 of the ’870 Patent states that “said first and second restrictor sleeves provide a gradual transition of the laterally outward expansion of said inner tube …”). And, the specification of the Patents-in-Suit explain that “sleeve 27 [at the first end of the hose] permits the inner tube 14 to gradually expand” (’870 Patent at 11:33-45) and that “sleeve 26 [at the second end of the hose] permits the inner tube 14 to gradually expand” (’870 Patent at 11:4-14). In light of the clear language from the claims and the specification, it is my opinion that no further definition or construction is necessary – the meaning of these claim terms are clear on their face given their plain and unambiguous language.

56. I understand that Winston Products asserts that each of these claim terms should be construed to mean: “a device that allows the [flexible] inner tube to expand gradually ***[1] from the tubular extension*** and ***[2] is permanently*** attached to the [first/second] end of the [flexible] inner tube and the [first/second] end of the [flexible] outer tube.” (emphasis added). This proposed construction adds the above two aforementioned limitations absent any indicia of inventor lexicography or disclaimer. But there is nothing in the claim language that mentions or requires either of these proposed additional limitations. Indeed, it is my opinion that a POSITA would not understand these claim terms to require either of these additional narrowing limitations that Winston Products seeks to include, nor are those concepts necessary to make the claimed invention. Moreover, it is my opinion that the introduction of the unclaimed feature – “tubular extension” – unnecessarily adds ambiguity to these otherwise easily understandable claim terms. Put simply, there is no basis to add either of these limitations to these easily understandable claim terms.

57. In light of the above, it is my opinion that a POSITA would fully understand the meaning of these claim terms based on the claim language and the specification of the Patents-in-Suit, and that therefore no construction of these claim terms is necessary.

D. (i) "a first securing device securing said first restrictor sleeve, said outer tube, and said inner tube to said first coupler" / "a first securing device securing said first restrictor sleeve, said flexible outer tube, and said flexible inner tube to said first coupler"

(ii) "a second securing device securing said another expansion restrictor sleeve, said outer tube, and said inner tube to said second coupler" / "a second securing device securing said second expansion restrictor sleeve, said flexible outer tube, and said flexible inner tube to said second coupler"

58. It is my opinion that these claim terms or phrases do not require a construction at least because they are easily understandable to a POSITA on their face, and also because each phrase is defined by the language of the claim itself.

59. I understand that Winston Products asserts that the claimed "securing devices" are means-plus-function limitations that should be construed pursuant to 35 U.S.C. § 112, sixth paragraph, to cover only the securing devices 34 and 40 shown in Figures 7 and 8 of the Patents-in-Suit, respectively. I further understand that, in direct contradiction of its proposed construction, Winston Products also asserts that these claim terms are indefinite under 35 U.S.C. § 112, second paragraph, because the specification allegedly does not discuss or describe any type of "securing device" and thus fails to disclose the corresponding structure to perform the claimed functions. My opinion is that these terms do not require a construction and I also disagree with both of Winston Products' assertions.

1. The "Securing Device" Limitations Do Not Require A Construction

60. A POSITA at the time of the invention would understand that a plain reading of these claim terms themselves simply describes either (1) *a first securing device* that secures the first restrictor sleeve, the outer tube, and the inner tube to the first coupler, or (2) *a second*

securing device that secures the second restrictor sleeve, the outer tube and the inner tube to the second coupler. The claims themselves as well as the specification both describe the claimed "securing devices" as simply any device that serves to attach the corresponding (i.e., first or second) restrictor sleeve, the outer tube, and the inner tube to the corresponding (i.e., first or second) coupler – nothing more. For example, Claim 7 of the '870 Patent states that the "first securing device" simply "secur[es] said first restrictor sleeve, said outer tube, and said inner tube to said first coupler," and that the "second securing device" simply "secur[es] said another expansion restrictor sleeve, said outer tube and said inner tube to said second coupler." And, the specification of the Patents-in-Suit states that "securing device 40 encompasses the outer sleeve 27, the outer tube 12, and the inner tube 14 and secures these elements to the tubular extension 36 [of the coupler 18]" ('870 Patent at 11:31-33) and that "securing device 34 encompasses the outer sleeve 26, the outer tube 12, and the inner tube 14 and secures these elements to the tubular extension 34 [of the coupler 16]" ('870 Patent at 10:65-67). Importantly, the specification specifically contemplates this broad scope by explaining that various *other* types of devices may be used to secure the restrictor sleeve, the outer tube, and the inner tube to the couplers and thus it would be understood by a POSITA that the claimed "securing devices" could be any known securing device. *Id.* at 11:13-16 ("Other types of connections, such as clamping and swaging can also be employed to secure the male coupler to the inner tube 14, the outer tube 12, and the sleeve 26."); *id.* at 11:45-47 ("Other types of connections, such as clamping and swaging can also be employed to secure the female coupler to the inner tube 14, the outer tube 12, and the sleeve 27.").

61. In light of the above, it is my opinion that a POSITA would fully understand the meaning of these claim terms based on the claim language and the specification of the Patents-in-Suit, and that therefore no construction of these claim terms is necessary.

2. The "Securing Device" Limitations Are Not Subject to 35 U.S.C. § 112, Sixth Paragraph

62. I understand that Winston Products asserts that the "securing device" limitations are means-plus-function limitations that should be construed pursuant to 35 U.S.C. § 112, sixth paragraph. I disagree. As an initial matter, and as discussed in Section V, *supra*, the lack of the term "means" in these claim limitations creates a rebuttal presumption that they are not means-plus-function limitations.

63. I understand, however, that the presumption can be rebutted if Winston Products can establish that the claimed "securing devices" fail to recite sufficiently definite structure or recite function without reciting sufficient structure for performing that function. I further understand that in an attempt to rebut this presumption, Winston Products asserts that "securing device" is a nonce term that does not recite sufficient structure. I disagree with Winston Products.

64. In my opinion, "securing device" is not a nonce word or merely a verbal construct that is used in a way that is effectively the same as the word "means." Rather, "securing device" would readily be recognized by a POSITA to have a sufficiently definite meaning as the name for structure in light of the claims and the specification.

65. For example, based on the claim language alone, a POSITA would easily recognize that the "securing devices" of the claimed hose are the structural components of the hose that secure or connect a restrictor sleeve, an outer tube, and an inner tube to a coupler of the hose. *See, e.g.*, '870 Patent, Claim 7. Notably, based on my experience in the field, a POSITA

reading Claim 7 of the ’870 Patent would readily understand the claim term “securing device” to be any type of structural element (or elements) that can be used to secure or connect a restrictor sleeve, an outer tube, and an inner tube to a coupler of the hose. Accordingly, a “securing device,” to a POSITA can be a screw, a nut and bolt, a securing ring, a clamp, a crimp, a swage fitting, etc. – all of which are structural elements that can be used to secure or connect a restrictor sleeve, an outer tube, and an inner tube to a coupler of the hose.

66. The specification also supports my opinion that the term “securing device” would be readily recognized by a POSITA as the structural component used for securing a restrictor sleeve, an outer tube, and an inner tube to a coupler. Indeed, the specification specifically shows and describes the different types of structural components that may be used to secure a restrictor sleeve, an outer tube, and an inner tube to a coupler of the hose. For example, Figure 8 of the Patents-in-Suit illustrates securing device or ring 40 as the structural component used to secure “the outer sleeve 27, the outer tube 12, and the inner tube 14 … to the tubular extension 36” of coupler 18 (’870 Patent at 11:31-33), and Figure 7 illustrates securing device or ring 34 as the structural component used to secure “the outer sleeve 26, the outer tube 12, and the inner tube 14 … to the tubular extension 34” of coupler 16 (’870 Patent at 10:65-67). The specification also identifies other structural components, such as clamps, crimps or swage fittings that can be used to secure a restrictor sleeve, an outer tube, and an inner tube to a coupler of the hose. *Id.* at 11:13-16, 11:45-47, 2:34-46, 3:37-47.

67. A POSITA would therefore discern from the claim language, the specification and their general knowledge that the term “securing device” is not used as a nonce term or generic abstraction, but rather as a specific reference to the structural elements of the claimed hose that secures or connects a restrictor sleeve, an outer tube, and an inner tube to a coupler of the hose.

In other words, the term “securing device” is broad, but identifiable as the term used to describe the various structural elements disclosed in the specification (as well as any other well-known securing devices) that perform the function of securing or connecting a restrictor sleeve, an outer tube, and an inner tube to a coupler of the hose. Notably, a POSITA would recognize that the claimed “securing devices” are not limited to the embodiments shown in Figures 7 and 8.

68. It is therefore my opinion that the “securing devices” claimed in the Patents-in-Suit would have a sufficiently definite meaning to a POSITA as the name for structure and that the terms should not be construed as means-plus-function limitations under 35 U.S.C. § 112, sixth paragraph.

69. I further note that the term “securing device” was not treated as a means-plus-function limitation by the Examiner of the Patents-in-Suit or their family members. This further confirms my opinion that “securing devices” is not a means-plus-function term.

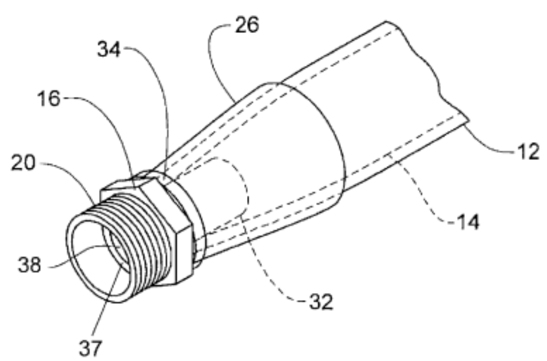
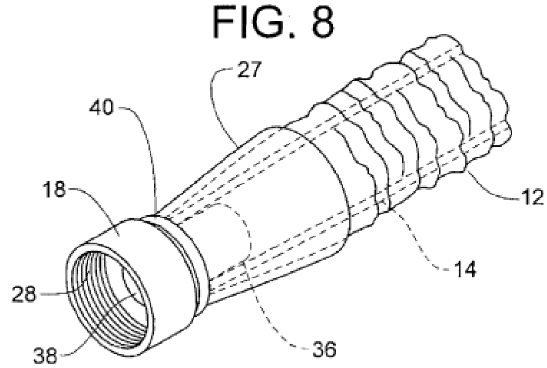
3. The “Securing Device” Limitations Are Not Indefinite Under 35 U.S.C. § 112, Second Paragraph

70. I understand that Winston Products also asserts that the “securing device” limitations are indefinite under 35 U.S.C. § 112, second paragraph, because the Patents-in-Suit allegedly do not disclose the corresponding structure to perform the claimed function of securing a restrictor sleeve, an outer tube, and an inner tube to a coupler. I disagree.

71. As an initial matter, my understanding is Winston Products has not asserted that the “securing device” limitations are indefinite under 35 U.S.C. § 112, second paragraph, generally. Rather, Winston Products has only asserted that the “securing device” limitations are indefinite as it relates to Winston Products’ assertion that these limitations are governed by 35 U.S.C. § 112, sixth paragraph. To the extent Winston Products later asserts that these limitations

are indefinite generally under 35 U.S.C. § 112, second paragraph, I reserve the right to supplement this opinion to address such assertions.

72. It is my opinion that, if the claimed "securing devices" are ultimately deemed to be means-plus-function limitations, they are definite under 35 U.S.C. § 112, second paragraph. A POSITA would understand that the Patents-in-Suit disclose at least securing rings 34 and 40, shown in Figures 7 and 8, as the structure for the claimed function of securing a restrictor sleeve, an outer tube, and an inner tube to a coupler. '870 Patent at 10:65-67, 11:31-33, Figs. 7-8. Below are Figures 7 and 8 from the '870 Patent illustrating securing rings 34 and 40:

Figure 7 of the '870 Patent	**Figure 8 of the '870 Patent**
FIG. 7 	FIG. 8 

73. It also my opinion that a POSITA would understand that the Patents-in-Suit disclose additional structure for the claimed function, including "[o]ther types of connections, such as clamping and swaging [that] can also be employed to secure the [] coupler to the inner tube 14, the outer tube 12, and the sleeve." *Id.* at 10:65-67, 11:31-33. A POSITA would have understood from this disclosure that any number of appropriate and well-known securing devices could be used to secure the restrictor sleeve, the outer tube, and the inner tube to the coupler of the hose. It is therefore my opinion that a POSITA would understand that the shared

specification of the Patents-in-Suit disclose sufficiently definite structure corresponding to the claimed function, enabling a POSITA to make and use the inventions.

74. My opinion is further supported by Winston Products' own admission that the Patents-in-Suit expressly disclose that the securing devices can be securing rings 34 and 37 shown in Figures 7 and 8, respectively. *See* Winston Products' Preliminary Claim Constructions and Supporting Evidence, served on Dec. 11, 2023, at 11-12 ("This term must be construed under section 112(f). The specification does not describe any securing device ***with the exception of securing device 40 in Figure 8***. ***Figure 8 illustrates the securing device 40 as some type of annular device that encompasses the restrictor sleeve, the outer tube, and the inner tube***.") (emphasis added); *see also id.* at 13-14 ("This term must be construed under section 112(f). The specification does not describe any securing device ***with the exception of securing device 34 in Figure 7***. ***Figure 7 illustrates the securing device 34 as some type of annular device that encompasses the restrictor sleeve, the outer tube, and the inner tube***.") (emphasis added). This is an express admission by Winston Products that the Patents-in-Suit do in fact disclose sufficient structure – i.e., securing devices 34 and 40 – for performing the claimed function.

I hereby certify that the facts set forth above are true and correct to the best of my personal knowledge, information, and belief, subject to the penalty of perjury, and are offered to a reasonable degree of engineering certainty.

Dated: December 29, 2023 By: ______________________
JAMES L. GLANCEY

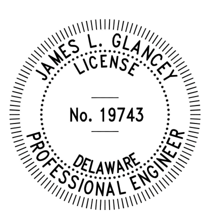


Exhibit A

James L. Glancey, Ph.D., P.E.

Curriculum Vitae (Since Promotion to Associate Professor in 1997)

Registered Professional Engineer (Mechanical): Delaware Reg. No. 19743

Education

Ph.D.	University of California, Davis	1991
M.S.	University of California, Davis	1987
B.S.	University of Delaware	1985

Professional Experience

- Professor, Mechanical Engineering & the College of Agriculture and Natural Resources, University of Delaware — 7/12 - present
- Associate Professor, Mechanical Engineering, University of Delaware — 9/97 – 6/12
- Associate Professor, Bioresources Engineering, University of Delaware — 7/97 – 6/12
- Assistant Professor, Bioresources Engineering, University of Delaware — 1/91 - 6/97
- Principle and Owner, Mechanical Design and Forensic Analysis LLC, Middletown, DE — 6/99 – present
- Partner, Structural Mechanics Associates, Haverford, PA — 7/12 – 6/19

Other Academic Appointments

- Academic Contact, Concentration in Manufacturing Systems, Dept. of Mech Engr. — 9/18 - present
- Faculty Coordinator, Student Machine Shop, College of Engineering — 7/16 – present
- Faculty Advisor, Resilient Builds Engineering Club, College of Engineering — 8/18 – present
- Faculty Advisor, Trap and Skeet Club, University of Delaware Chapter — 8/17 – present
- Faculty Advisor, Alpha Gamma Rho, Univ. of Delaware Chapter — 9/15 - present
- Affiliate Faculty, Center for Composite Materials, Univ. of Delaware — 7/03 - present
- Engineer, Cooperative Extension Service, Univ. of Delaware — 7/03 - present
- Faculty Member, Center for Biomedical Engineering Research, Univ. of Delaware (now the Center for Biomechanical Engineering Research, Univ. of DE) — 9/03 – present

Recognition and Awards

- The University of Delaware George M. Worrilow Award for Outstanding Alumni. 2017.
- The Delaware Farm Bureau Distinguished Service to Agriculture Award. 2014.
- The Water Resources Association of the Delaware River Basin's 2011 Government Award - (co-recipient with Governor Jack Markell; Secretary of Environment and Energy Collin O'Mara; Secretary of Agriculture for the State of Delaware, Edwin Kee; Mayor of Middletown, Delaware, Kenneth Branner; and President of Artesian Water, Dian Taylor). 2011.
- The Delaware Vegetable Growers Association Distinguished Service Award. 2011.
- Selected as Associate Editor, Power and Machinery Division, The American Society of Agricultural and Biological Engineers, 2004-2012.
- Nominated for Excellence in Academic Advising, University of Delaware, 2006.
- Inducted into the University of Delaware's Mentors' Circle. 2001.
- Dean's Merit Award, University of Delaware, 2001.
- Nominated for Excellence in Teaching Award, University of Delaware College of Engineering, 2000.
- North Central Campus Senior-Faculty Recognition Award, University of Delaware, 2000.
- Excellence in Academic Advising, University of Delaware. 1997.
- Society of Automotive Engineers Recognition Award. 1997, 2004 Off-Highway and Powerplant Exposition.
- *Awards Received by Student Advisees:*
  - Solar Decathlon Event Sponsored by NREL, UD College of Engineering Team Submission. 2021. Top Ten Finalist.
  - American Society of Mechanical Engineers (ASME), Delaware Section Student Design Award. 2019. Harper Drake, Mary Galanek, John Hughes, Jess Tentindo. $500.
  - American Society of Mechanical Engineers (ASME), Delaware Section Student Design Award. 2013. Benjamin J. Hockman, Gerad M. Lieb, Gregory N. Ohnemus, Luke A. Walmer. $500.

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- American Society of Mechanical Engineers (ASME), Delaware Section Student Design Award. 2013. Brett A. Davis, David L. A. Eisensmith, Laura E. Quinn, Stephen J. Schafer. $500
- The 2009 American Society of Mechanical Engineers (ASME) International Student Design Competition, Second Place Award Recipients (Raquel Ciappi, Brad Miller, Steve Petfield, Chris Uthgenannt). $1000.00.
- The 2008 ASME International Student Design Competition, Tied for First Place Award (Sean Collins, Sarah Mabel, Dan Shannon, and Doug Erikson). $2,500.
- The 2008 ASME International Student Design Competition, Tied for First Place Award (Jess Dibelka, Julianne Twomey, and Mark Steimer). $2,500.
- Sigma Xi (University of Delaware Chapter) Undergraduate Research Thesis Award (Janelle Konchar)
- Society for the Advancement of Materials and Processing (SAMPE) 2006 National Research Award (Michael Fuqua, 2nd Place), $1,000.
- Honors Degree with Distinction Thesis (Kerrie Smith, Richard Herseim, Scott Kasprzak, Michael Fuqua)
- Degree with Distinction Thesis (Janelle Konchar, Dan Brisach, Matt Griffith)
- Honors Program Undergraduate Research Summer Fellowship (Scott Kasprzak, Michael Fuqua)
- Hayward Fellowship for Undergraduate Research (Kerrie Smith, Richard Herseim, Scott Kasprzak)
- Nowinski Award for Undergraduate Research in Mechanical Engineering (Rich Herseim)
- Science and Engineering Scholars (Richard Herseim, Ian Cosden, Michael Fuqua, Janelle Konchar, Jessie Krisher, John Nasr, Mathew Griffith, Stephan Petfield, Connie Helstosky)
- Delaware Water Resources Center Summer Internship (Kerrie Smith, Mathew King)
- Undergraduate Research Supply & Expense Grants (Daniel Brisach (2), Matthew Griffith (3), John Nasr, Scott Kasprzak (2), Janelle Konchar (3), Jesse, Krisher, Mike Fuqua (2), Dan Muhlenforth, James Moore, Jennifer Lawrence, Dominic Schiavoni, Eric Busby, Richard Herseim (2), Gwen Thorsen (2), Dustin Fryberger, Kerrie Smith (2), Dawn Cintavey, Tony Nasr, Annie Tseng, Mike Fyock, Dan Meckley, Chad Stover, Dan Hoffstetter) ($5,000 total for all students).
- Colonial Academic Alliance Undergraduate Research Symposium Invited Presenter (Janelle Konchar, Kerrie Smith)
- Center for Biomedical Engineering Research Symposium Presenters (Justin Alms, Jennifer Lawrence, James Moore, Dominic Schiavoni, Dan Muhlenforth, Jonathan Fitzgibbons, Barbara Tuesday, Rich Herseim, Janelle Konchar, Jessie Krisher)
- Center for Composite Materials Undergraduate Research Fellowship (Michael Fuqua, Matt Griffith, Steven Petfield)
- Outstanding Senior Researcher, Center for Composite Materials (Scott Kasprzak, Daniel Brisach)
- Center for Composite Material Graduate Achievement Award (Justin Alms, co-advised w/ S. Advani)
- College of Engineering Graduate Student Laird Fellowship (Jingbo Wang, co-advised w/ J. Vinson)
- Center for Composite Materials R.L. McCullough Scholars Award (Justin Alms, co-advised with S. Advani)

PROFESSIONAL SOCIETIES

- American Society of Mechanical Engineers
- American Society of Agricultural & Biological Engineers
- Society for the Advancement of Material and Process Engineering
- International Society of Beverage Technologists
- Society of Automotive Engineers
- Delaware Association of Professional Enrs
- American Society of Safety Professionals
- American Concrete Pumping Association

TEACHING

COURSES TAUGHT AT UNIVERSITY OF DELAWARE

- EGTE 125/167 Freshman Seminar (96F, 97F, 98F).
- EGTE/BREG 209 Computer-Aided Drafting (06S, 08S, 09S, 10S, 11S).
- EGTE 435 Machinery Design (96F, 98S, 01S, 03S, 05S, 07S).
- EGTE 450 Practicum in Industry (06S).
- EGTE 467 Issues in Production Agriculture (02S).
- EGTE 366/466 Undergraduate Independent Study (01F, 02S, 03F, 04S, 06F, 07W, 07S).
- AGEG 666 Graduate Independent Study (97S).
- BREG 666 Graduate Independent Study (08F, 10S).
- MEEG 202 Computer-Aided-Engineering Design (05S, 11S, 12S).
- MEEG 301 Machine Design: Kinematics (11F - 20F).
- MEEG 304 Machine Design: Elements (99S, 00S, 12S-21S).

- MEEG 401 Senior Design (99F/S, 00F-05F, 07F-21F).
- MEEG 445 Senior Research (00-06).
- MEEG 366/466 Independent Study (06-21S).
- MEEG 467 Special Topics in Engineering Design (03S, 04S).
- MEEG 666 Graduate Independent Study (08S, 09F, 19S).
- MEEG 866 Graduate Research (02F, 03S, 03F, 04S).
- UNIV 111 First Year Experience Freshman Seminar (08F).
- UNIV 401/402 Senior Thesis, University-Wide Instructor of Record (07F, 08S).
- UNIV 401/402 Senior Thesis Advisor (02F, 03S, 03F, 04S, 04F, 05S, 05F, 06S, 06F, 07S).

INVITED LECTURES

- MEEG 653/453, Manufacturing Processes. Two Lectures: *Computer-Aided Engineering and Manufacturing & Automation for Manufacturing.* (2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021).
- MEEG 304, Machine Design. *Developing Design Packages for Communicating Engineering Solutions*. (2008).
- EGTE 440, Plant Layout. *Basics of Vibration and Noise-Related Industrial Hygiene and Engineering Controls to Reduce Exposures and Injuries*. (2007).
- UNIV 401, Senior Thesis. *Developing an Effective Research Presentation: Fall Meeting of the Senior Thesis Candidates*. (2004, 2005, 2006).
- UNIV 401, Senior Thesis. *Using and Not Abusing Technologies to Deliver Research Presentations (a.k.a. Avoiding Death by PowerPoint).* (2005, 2006).
- PLSC 302, Vegetable Science. *Precision Ag for Horticultural Crops*. (2000).
- ANFS 421, Poultry Production. *Pollution Prevention Technologies for the Delmarva Poultry Industry.* (1999).
- PLSC 302, Vegetable Science. *Mechanization & Engineering in Production Horticulture & Introduction to GPS Technologies.* (1999, 2010).
- EGTE 443, Instrumentation. *Basics of GPS and DGPS.* (1998).

GRADUATE AND UNDERGRADUATE THESIS

- <u>Ph. D. Students:</u>
  - First Advisor:
    - Justin Alms, Ph.D. in Mechanical Engineering (with Dr. Suresh Advani, 2006-2010).
      Thesis: <u>Closed Loop Control Strategies with VARTM for Manufacturing Large-Scale Composites.</u>
  - Committee Member:
    - Hao Liu, Ph.D. in Mechanical Engineering (2018)
    - Thomas Cender, Ph.D. in Mechanical Engineering (2017)
    - Hatice Sas, Ph.D. in Mechanical Engineering (2015)
    - Hao Lu, Ph.D. in Mechanical Engineering (2014)
    - John Gandolf, Ph.D. in Mechanical Engineering (2014)
    - Parag Nittur, Ph.D. in Mechanical Engineering (2013).
    - Thomas Cender, Ph.D. in Mechanical Engineering (2013).
    - Hatice Sas, Ph.D. in Mechanical Engineering (2013).
    - Liang Chen, Ph.D. in Mechanical Engineering (2010).
    - Swapnil Garge, Ph.D. in Chemical Engineering (2007).
    - Kalyan Mankala, Ph.D. in Mechanical Engineering (2006).
    - Jeff Lawrence, Ph.D. in Mechanical Engineering (2005).
    - Jie Sheng, Ph.D. in Mechanical Engineering (2005).
    - Chris Foster, Ph.D. in Mechanical Engineering (2005).
    - Xiangyu Wang, Ph.D. in Mechanical Engineering (2004).
    - Luis Crespo, Ph.D. in Mechanical Engineering (2002).

- <u>M.S. Students:</u>
  - First Advisor:
    - Ajit R Nalla, Master in Mechanical Engineering (2006).
      Thesis: <u>Modeling and Adaptive Control of Vacuum Assisted Resin Transfer Molding Systems with Segmented Injection and Vacuum Lines.</u>

- Jingbo Wang, Master in Mechanical Engineering (with J. Vinson, 2002),
  Thesis: Transverse Shear and Non-Linear Deformation Effects on the Physical Properties of Sandwich and Laminate Composite Plates.
- Manu Krishnan, Master in Mechanical Engineering (with J. Sun, 2000).
  Thesis: Adaptive Control Strategies for Precision Agriculture Machines.

- Committee Member:
  - Jeff Lugo Master of Mechanical Engineering. (2013).
  - Joe Walther, Master of Mechanical Engineering. (2011).
  - Kenneth Okonkwo, Master of Mechanical Engineering. (2010).
  - Piyush Bubna, Master of Mechanical Engineering (2010).
  - Justin Merotte, Master of Mechanical Engineering (2009).
  - Darren Brown, Master of Mechanical Engineering (2008).
  - Prabhas Bhat, Master of Mechanical Engineering (2007).
  - John Fader, Master of Mechanical Engineering (2006).
  - Thomas Shipman, Master of Mechanical Engineering (2006).
  - Stephanie Frangakis, Master of Mechanical Engineering (2005).
  - Sean McIntosh, Master of Mechanical Engineering (2005).
  - Yeliz Karakaya, Master of Mechanical Engineering (2005).
  - Scott Lynch, Master of Environmental and Energy Policy (2004).
  - James Arters, Master of Mechanical Engineering (2004).
  - Rajkiran Madangopal, Master of Mechanical Engineering (2004).
  - Mathieu Devillard, Master of Mechanical Engineering (2003).
  - Mark Lynch, Master in Food & Resource Economics (1998).

- Undergraduate Degree with Distinction and Honors Degree with Distinction Thesis
  - First Advisor:
    - Daniel Brisach, Degree with Distinction in Mechanical Engineering (2006-07).
      Thesis: Vibration Transmission Measurements in the Hand and Arm from Impacting Components.
    - Matt Griffith, Degree with Distinction in Mechanical Engineering (2006-07).
      Thesis: High Strain Rate Characteristics of Mineral Reinforced Polymers.
    - Janelle Konchar, Degree with Distinction in Mechanical Engineering (2005-06).
      Thesis: Modeling & Testing of a New Polymer-Based Impact Tool Design to Reduce Biomechanical Injuries.
    - Michael Fuqua, Honors Degree with Distinction in Mechanical Engineering (2005-06).
      Thesis: A Port Injection System and Controller for VARTM.
    - Scott Kasprzak, Honors Degree with Distinction in Mechanical Engineering (2004-05).
      Thesis: VARTM Flow Modification with Machine Vision and Robotic Control.
    - Richard Herseim, Honors Degree with Distinction in Mechanical Engineering (2003-04).
      Thesis: A Full Scale Apparatus for Measuring the Forces Exerted on the Human Femur During Falls.
    - Kerrie Smith, Honors Degree with Distinction in Mechanical Engineering (2002-03).
      Thesis: An Autonomous Whole Water Column Environmental Monitoring System with Telemetry.

  - Second Advisor:

Rossiny Beaucejour	(Mechanical Engineering)	2013-14
John Eisenbrey	(Mechanical Engineering)	2004-05
Michael Kutzer	(Mechanical Engineering)	2004-05
Thomas Shipman	(Mechanical Engineering)	2003-04
Kristin Huesmann	(Mechanical Engineering)	2002-03
Karin Wood	(Bioresources Engineering)	2002-03
Ryan Jost	(Food & Resource Economics)	2000-01

  - Third Reader:

Yuk-J Leung	(Mathematical Sciences)	2012-13
Jennifer Bruhns	(Computer & Info. Science)	2012-13
Casey Casalnuovo	(Computer & Info. Science)	2012-13

Vikramjit Rathee	(Biological Sciences)	2012-13
Matthew Saponaro	(Mathematical Sciences)	2012-13
Ricky Shum	(Mathematical Sciences)	2012-13
Matthew Stagitis	(Computer & Info. Science)	2012-13
Rebecca Aiken	(Civil Engineering)	2011-12
Michelle Allen	(Computer Science)	2011-12
Cory Bart	(Computer Science)	2011-12
Nicholas Troup	(Physics & Astronomy)	2011-12
Stephanie Countess	(Civil Engineering)	2010-11
Kent Davidson	(Civil Engineering)	2010-11
Craig Davis	(Civil Engineering)	2010-11
Geoffrey Dilg	(Civil Engineering)	2010-11
Christine Sutkowski	(Civil Engineering)	2010-11
Nathan Mayercsik	(Civil Engineering)	2009-10
Melissa Stewart	(Civil Engineering)	2009-10
Jeffrey Bosco	(Chemical Engineering)	2008-09
Michael Daugherty	(Health & Exercise Science)	2008-09
Emily Gardinier	(Physical Therapy)	2008-09
Katherine Monahan	(Health & Exercise Science)	2008-09
Jeff Rockwell	(Civil Engineering)	2008-09
Jason Schoenfeld	(Health & Exercise Science)	2008-09
Adam Blomberg	(Physics & Astronomy)	2007-08
Zachary Fry	(Computer & Info. Science)	2007-08
Andrew Gearhart	(Computer & Info. Science)	2007-08
Hailey Guerriero	(Physics & Astronomy)	2007-08
Joshua Kirby	(Computer & Info. Science)	2007-08
Donald Andre Scott	(Computer & Info. Science)	2007-08
Steven Anton	(Physics & Astronomy)	2006-07
Todd Molnar	(Mathematical Sciences)	2006-07
Daniel Osborne	(Physics & Astronomy)	2006-07
Ming-Jay Shiao	(Electrical Engineering)	2006
Patrick Collar	(Computer & Info. Science)	2005-06
Janine Janoski	(Mathematical Sciences)	2005-06
Kathryne Sharp	(Mathematical Sciences)	2005-06
Zachary Loman	(Electrical Engineering)	2005-06
Peter Steijn	(Computer & Info. Science)	2005-06
Ming-Jay Shiao	(Electrical Engineering)	2005-06
Anteneh Anteneh	(Computer & Info. Science)	2004-05
Michael Brennan	(Computer & Info. Science)	2004-05
Lewis Fishgold	(Computer & Info. Science)	2004-05
Ki-Yong Kim	(Computer & Info. Science)	2004-05
Brendan Farmer	(Mathematical Sciences)	2004-05
Michael Lowinger	(Chemical Engineering)	2003-04
Richard Lunt	(Chemical Engineering)	2003-04

VISITING SCHOLARS AND STUDENTS

- Guillaume Lecore. 4th Year Plastics & Composites Process Engineering, *Ecole des Mines de Douai*, Douai, France. Automation of the VIPR process for composite manufacturing. (co-advised w/Dr. Suresh Advani). 2009.
- Laurent Garnier, 4th Year Mechanical Engineering, *Ecole des Mines de Douai*, Douai, France. Evaluation of VARTM control strategies to improve resin filling characteristics. (co-advised w/Dr. Suresh Advani). 2008.
- Aude Catry, 4th Year Mechanical Engineering, *Ecole des Mines de Douai*, Douai, France. Evaluation of VARTM control strategies to improve resin filling characteristics. (co-advised w/Dr. Suresh Advani). 2008.
- Benoit Lelievre. M.S., Department of Mechanical Engineering, *Universite de Bretagne Sud*, Lorient, France. Measurement and Control of the Resin Flow in Composite Pre-forms with Flow Disturbances and Variable Permeability. 2003.

- Yuen-Yong Leong, M.S., Electrical Engineering, *Imperial College London*, South Kensington campus, London, England. System Identification and Controller Design for a Hydrostatic Drive New Holland Windrower. 2002.
- Dr. Zhang Zong, Ph. D. Associate Professor, Department of Mechanical Engineering, *Beijing University of Technology*, Beijing, China. Modeling and Experimental Evaluation of the Wear in a Miniature Vane Pump Used for the Evaluation of Hydraulic Fluid Performance. 1999-2001 (w/ Dr. Michael Keefe).

Special Educational Programs and Activities

- *Solar Decathlon Competition.* (2000-2001). Nationwide design competition to develop and operate an 800 ft^2 solar powered house – the team consisted of three faculty advisors, 30 students, 40 industrial sponsors, and several technical consultants. The University of Delaware house, along with the 9 other houses from universities in the U.S. and Puerto Rico, was built and operated on the National Mall in Washington, D.C. for a 10-day period in October, 2002. Over 90,000 visitors toured the site, and the U of D house placed sixth in the competition. Faculty Advisors: Drs. Lian Ping Wang, Ajay Prasad, and James Glancey.
- *Travel Abroad Program to California/Mexico*. Winter Session 2002. Co-Sponsored by the Departments. of Plant and Soil Sciences & Bioresources Engineering. Faculty Directors: Ed Kee and James Glancey. <u>Cancelled due to terrorist activities of September 11, 2001.</u>
- *Charter High School Senior Research Project Advisor*
  - Derrek Jones. 2004-05. Performance of a non-contact temperature sensor for avian egg embryo temperature measurement. Senior Research Project for the *Charter School of Wilmington*.
  - Phillip Franklin. 2004-05. Biomechanics of a human climbing a fiberglass step ladder. Senior Research Project for the *Charter School of Wilmington*.
- *Summer Research Internship*
  - Kurt Hayes. 2011. Comparison of flashspun high-density polyethylene fibers to other conventional polymer fabrics for the separation of oil from water. *Rowen University*, Glassboro, DE.
  - Erin McCaul. 2005. Estimating physical properties required for computing the forces on the upper femur during falls. *St. Marks High School*, Wilmington, DE.
- *High School Sophomore Science Fair Project Advisor*
  - Samir Streatfield. 2011-12. Design of a grinder to accelerate composting of food wastes. *Unionville High School*. Delaware Valley Science Fair, Unionville, PA.
  - Amee Raval. 2006-07. Measuring the Heating Value from Several Different Bio-Diesel and E-Diesel Fuels. Sophomore Science Fair for the *Charter School of Wilmington*, Wilmington, DE.
  - Sam Nobles, 2005-06. Testing of Ethanol-Based and Soy Oil-Based Diesel Fuels in Commercial and Industrial Engines. Sophomore Science Fair for the *Charter School of Wilmington*.
  - Shane Furn. 2005-06. Particulate Emission Measurements from Several Biofuels in Commercial and Industrial Engines. S
  - Sophomore Science Fair for the *Charter School of Wilmington*.
- *Coach for the Science Olympiad.* Lectures and Demonstrations on Simple Machines. Mario Musumeci and Adam Smith. (2008).
- *New Castle County Annual Science Fair Judge and American Society of Mechanical Engineers Award Presenter.* (2006, 2008, 2009, 2010). Stanton, DE.
- *Presentations and Career Fairs for High School Student Groups:*
  - Engineering as a Profession. 2012. Middletown High School, Middletown, DE.
  - What's a Professional Engineer? 2008, 2009. Middletown and Appoquinimink High Schools Career Fair.
  - Engineering as a Profession. 2007. St. Marks High School Career Fair, Wilmington, DE.
  - Biomechanics: Engineering for (and of) Humans. 2004. *Outreach seminar for the Resources for Successful Engineers (RISE) program*, Students from the Philadelphia School District, Newark , DE.
  - Who's Really Protecting Me? Engineers Who Design and Develop Products! 2003. *Outreach seminar for the Resources for Successful Engineers (RISE) program*, Students from the Philadelphia School District, Newark, DE.

Undergraduate Student Projects Advised for Credit (Independent Study or Honors Degree Requirement), 3 Credits Unless Otherwise Noted

1. Anuj Gandhi. 2019. Scaling of a silica column manufacturing process for gas chromatographs. Sponsored by Advanced Materials Technology, Wilmington, DE. (Graduate Student)

2. Greg Driscoll and Drew McQuiston. 2019. Integration of a cooperative robot into the assembly process for silica-based reactive columns in liquid chromatographs. Newport Manufacturing Site, Agilent Technologies, Wilmington, Delaware.
3. Mary Galanek. 2018. Fatigue analysis of a four bar linkage. Sponsored by Siemen Healthcare Diagnostics. (Honors Degree Requirement).
4. Michael Palmer. 2018. Testing of an angled gear worm drive for medical display devices. Sponsored by Southco Inc., Concordville, PA. (Honors Degree Requirement).
5. Greg Driscoll. 2018. Stepper motor sizing as an alternative drive for a cooperative robot tube feeding system. Sponsored by Newport Manufacturing Site, Agilent Technologies. (Honors Degree Requirement).
6. Drew McQuiston. 2018. Staticially significant testing of a tube singulation mechanism. Sponsored by Newport Manufacturing Site, Agilent Technologies. (Honors Degree Requirement).
7. Kanak Chattopadhyay. 2018. Evaluation of an automated bottle cap torqueing system for the filling line of consumables reagent bottles. Sponsored by Siemens Healthineers, Glasgow, DE.
8. Matt Blasi, Tom Celenza, Matt Seitel, Alex Nugent. 2018. Implementation of a cooperative robot for Computer Numerical Control fabrication of Plexiglas shields. Sponsors by Norwalt Design.
9. Luke Szewczak. 2018. Software and laboratory assignment development for the 3-axis Mazak milling machine in Spencer Lab. Sponsored by the Department of Mechanical Engineering (6 credits)
10. Matt Hall, Sarah Ago, and Ricky Hahn. 2018. Redesign of a 3d adjustment system for an optical HASMAT chemical detector. Sponsored by Smith Detection, Edgewood, Maryland.
11. Marisa Bisram. 2017. Modeling the enclosure environment on a 3-axis mill using coolant mist. Sponsored by Depuy Synthes. (Honors Degree Requirement).
12. Shannon Russell. 2017. Semi-automated extrusion loader for reagent vessels. Sponsored by Siemens Healthcare Diagnostics.
13. Connor Bydlon. 2016. Hopper transfer process for extruded plastic cuvette holders. Sponsored by Siemens Healthcare Diagnostics. (Honors Degree Requirement).
14. Steven Davis and Adam Smith. 2016. Test system for qualifying silicon lids on reagent delivery trays. Sponsored by Siemens Healthcare Diagnostics.
15. Michael Junken. 2015. Optimized design for the next generation plate lifting system for composite sample manufacturing. Sponsored by GE Aviation.
16. Steve Todderud. 2015. Developing of a tailgate-based bale weighing system for large round balers. Sponsored by Case-New Holland Industrial, New Holland, PA.
17. Hunter Bachman. 2015. Preventative maintenance statistical analysis for a tube manufacturing process. Sponsored by Superior Tube. Collegeville, PA (Honors Degree Requirement).
18. Rebecca Runkle. 2014. Automation of composite preforms into an autoclave for curing. Sponsored by GE Aviation, Newark, DE. (Honors Degree Requirement).
19. Michael McClintock. 2014. Integration of load measurement pins into the rear door of a round baler. (Honors Degree Requirement).
20. Derrick Herr. 2013. Modeling and testing of a robotically inserted surgical needle. Sponsored by Dr. Peter Popper.
21. Adrian Sawyer. 2013. Automation of honeycomb structure curing during manufacturing. Sponsored by Alcore, Edgewood, MD. (Honors Degree Requirement).
22. David Chun and Devon Prate. 2012. Development of a manufacturing process for composite honeycomb structures for aerospace applications. Sponsored by Alcore, Edgewood, MD.
23. David Eisensmith. 2012. Improved welding method for precision wound temperature sensors for aircraft applications. Sponsored by Sensing Devices, Inc.
24. Chanel Aldrich. 2012. Modeling and testing for a composite cap for impact tools. Sponsored by Hard Cap, LLC.
25. Michael Yeager. 2011. Forming process for composite plate manufacturing. Sponsored by the The Dupont Co. (Honors Degree Requirement).
26. Eric Wurtzel. 2011. Laminated aluminum expandable structures. Sponsored by Alcore, Edgewood, MD. (Honors Degree Requirement).
27. Daniel Russach. 2010. Failure modes analysis of a blood analysis machine using FMEA and Fault Tree techniques. Sponsored by Siemens Healthcare Diagnostics.
28. John Zerhusen. 2010. Implementation and validation of a non-contact torque test for a blood pump assembly process. Sponsored by Terumo Cardiovascular.
29. Connie Helstosky. 2010. Photovoltaic system sizing for a solar powered facility for the University of Delaware Creamery.

30. Kristen Saksa. 2010. Computer-Aided drafting methods for the University of Delaware Botanical Gardens. (1 credit).
31. Jennifer Iskai. 2009. Design of an automatic adhesive application process to attach an acrylic impeller to a pump motor shaft for the artificial heart-lung oxygenator. Sponsored by Terumo Cardiovascular.
32. Christopher Uthgenannt. 2009. Measurement of airflow characteristics of various disc mower design configurations. Sponsored by Case-New Holland. (6 credits)
33. Ronit Lilu. 2008. Implementation plan for lean manufacturing of an artificial heart-lung oxygenator. Sponsored by Terumo Cardiovascular.
34. Kasey Gust. 2008. Integration of an automated pressure regulator setting system for oxygen bottle manufacturing. Sponsored by Siemens Corp.
35. Daniel Brisach. 2008-09. Development of PWM charging strategies for ultracapacitors used on mobile equipment for energy storage. Sponsored by Case New Holland.
36. Mark Steimer. 2008. Control circuit simulation and prototyping of vehicle energy storage systems using ultracapacitors. Sponsored by Case New Holland
37. Michael Brill. 2008. Design and prototyping of a novel sanitary fly swatter (US Patent No. 6,957,510). Sponsored by Laura Simon, Esquire, Wilmington, DE.
38. Sean Collins and Doug Ericson. 2008. Modeling and experimental validation of an on-board hydraulic bale weighing system for round balers. Sponsored by Case New Holland. (3 credits for each student)
39. Dan Pron. 2007. Confined compression characteristics of a mineral reinforced polymer. Sponsored by Hard Cap, LLC.
40. Daniel Gempeshaw. 2007. Kinematic analysis of a composite marine seat structure for military applications. Sponsored by Revenge Composites (in fulfillment of his Honors Capstone Requirement).
41. Tom Coombes. 2007. Design and development of a hand-crank dynamometer as a hands-on museum activity. Sponsored by the Delaware Ag Museum. (4 credits)
42. Dan Pron. 2006-07. Testing of polymers for impact durability on a hammer face. Sponsored by Hard Cap, LLC.
43. Jesse Krisher. 2006. Development of an ALGOR finite element model for the prediction of femoral fractures from human falls. Sponsored by the DuPont Co.
44. Beth Miller, Erik Pearson, and James Woodhouse. 2006. Embedded controller development and vehicle testing of a drive-by-wire propulsion system for a windrower. Sponsored by CNH America, LLC. (3 credits each)
45. Matt Griffith. 2006. High strain rate testing of reinforced polymer inserts for power tools using a Split Hopkins Bar. Sponsored by Hard Cap, LLC.
46. John Armstrong and Greg Stewart. 2005. Design and testing of a mechanical harvesting system for indoor, closed system tilapia production. Sponsored by Blair View Aquaculture Farm. (3 credits each).
47. Julia Levinson. 2005. Automated measurement of laminate bond strength for substrates bonded to Teflon membranes. Sponsored by W.L. Gore and Associates.
48. Craig Livingston. 2005. Computer-aided-drafting fundamentals (1 credit).
49. Barry Levinson. 2005. Solid modeling with mechanical desktop (1 credit).
50. Mark Deaver. 2004-05. Parametric modeling and finite element analysis of disposable testing components for measuring laminate bond strength. Sponsored by W.L. Gore and Associates.
51. Gwen Thorsen. 2003-04. Software development and testing for the automatic transmission of data via a cellular modem. Sponsored by the Delaware Department of Natural Resources and Environmental Control. (6 credits)
52. Eric Busby. 2004. Development of a remote controlled drip tape cutter for drip tape laying equipment. Sponsored by Busby Farms.
53. Jennifer Lawrence and James Moore. 2004. Development of a test stand for the vibration analysis of power tools. Sponsored by Baltimore Tool Works, Inc. (3 credits each)
54. Dominic Schiavoni. 2004. Design of a drop tower for constant energy impact testing. Sponsored by Baltimore Tool Works, Inc.
55. Dan Muhlenforth. 2004. Design and testing of low vibration accessories for hand-struck tools. Sponsored by Baltimore Tool Works, Inc.
56. Derrick Dickerson. 2004. Development of an automated test device for evaluating the wear characteristics of poultry nipple drinkers. Sponsored by the Delaware Cooperative Extension Service. (co-advised w/ Gary Van Wicklen).
57. Eric Busby. 2004. Development and testing of a device for accelerated life testing of an *Air Pogo* toy. Sponsored by Leavis and Rests, P.C.
58. Dan Muhlenforth. 2003-04. Software and sensor arrangement for determining the frequency content of hand-mounted accelerometers. Sponsored by Baltimore Tool Works, Inc.

59. Dominic Schiavoni. 2003-04. Measurement of vibration transmitted to the hand from hand-struck and power tools. Sponsored by Baltimore Tool Works, Inc.
60. Dominic Pellegrenio. 2003. Design of a steel frame flooring system with EPS foam insulation. Sponsored by Ecothermal Panel Systems, Inc.
61. Mike Fyock and Dan Meckley. 2003. Structural analysis and hydraulic automation of a prototype kicker for round balers. Sponsored by Case New Holland, Inc. (3 credits each)
62. Annie Tseng. 2003. An automated testing machine and methodology for ceramic wafer substrates used for blood sample analysis. Sponsored by Dade Behring.
63. Matt Mitch. 2002. Development of a computer design tool for the cooling systems on skid-loaders. Sponsored by Case-New Holland, Inc.
64. Dawn Cintavey. 2002. Finite element analysis of extruded aluminum structures. Sponsored by National Forensics Engineers, Inc.
65. Mark Orgovan and Dan O'Brien. 2002. Evaluation of a two-piece chisel system designed with a high performance engineering polymer impact surface. Sponsored by Baltimore Tool Works, Inc. (3 credits each)
66. Pete Truitt. 2002. Automated pneumatic capping system for dental adhesive capsules. Sponsored by Densply-Caulk.
67. Julian Jones and Matt Dougherty. 2002. Development of an automated cutter for plastic sleeves. Sponsored by Xymid, LLC.
68. Tony Nasr. 2002. Design and Instron testing of a framing system and fasteners for electrically insulated attachment of solar panel systems to steel-framed structures. Sponsored by the UD Solar Decathlon and AstroPower.
69. Tony Nasr. 2002-03. Ergonomic testing trials of a new low vibration, hand-struck chisel system. Sponsored by Baltimore Tool Works, Inc.
70. Mike Vassallo. 2002. Development of high volume compression system for preparing inoculated silage samples. Sponsored and co-advised by Dr. L. Kung.
71. Rich Herseim. 2002. Design, analysis and testing of plastic drivetrain shields on Case-New Holland windrower headers. Sponsored by Case-New Holland, Inc.
72. Pete Truitt. 2002. Finite element analysis of the impact of a hammer-tool system. Sponsored by Baltimore Tool Works, Inc.
73. Andrew Drysdale. 2002. The current state of photovoltaic technology. (as part of his Honors Degree Capstone Requirement in Mechanical Engineering).
74. Doug Cook, Jeff Gordon, and Matt Dunson. 2001. Development of *AutoGap*: a control system for the automatic adjustment of windrower roll gap. Sponsored by Case New Holland, Inc. (3 credits each)
75. Ian Cosden. 2001. Control software development and field testing for the closed loop control of DC motor angular displacement for mower-conditioner roll gap adjustment. Sponsored by Case-New Holland, Inc.
76. Tim Filasky. 2001-02. Design of a precision push planter. Sponsored by Delaware Cooperative Extension and Rogers Seed Co.
77. Mac Cushing. 2001-03. Design of an automatic fabric feed system for a numerically controlled laser cutter. Sponsored by Cirrus Engineering.
78. Nikki Rossi. 2001. Feasibility of an on-line degradation sensor for soy-based hydraulic fluids. Part of a project funded by DuPont. (co-advised with Mike Keefe)
79. Chad Stover. 2000. Development of improved vaccination system for day-of-age Marak's vaccine. Sponsored by the Allen Laboratory, University of Delaware.
80. Andy Park. 2000. Development of learning modules for CAD/CAM and CNC machining for undergraduate design courses. (co-advised with Dr. Michael Keefe).
81. Matt Dunson and Yuen Yoong Leong. 2000. Demeter project system ID and PID controller design. Sponsored by New Holland, N.A.
82. Matt Behr. 1999. Development of a non-invasive sensing method for the measurement of watermelon sugar content. Sponsored by University of Delaware Cooperative Extension.
83. Ken Miller and Rob Banks. 1998. Experimental evaluation of a subcutaneous vaccination system for day-of-age Marek's vaccine. (co-advised with Dr. Michael Keefe).
84. John Filasky. 1997. Design requirements for a watermelon harvester. Sponsored by University of Delaware Cooperative Extension.
85. Dan Hoffstetter. 1997. Yield monitor designs for vegetable harvesters. Sponsored as part of a grant from FMC Corporation.

SCHOLARSHIP

BOOK CHAPTERS

1. S. Zhengjie Jia, J. Gunasekera, and J.L. Glancey. 2023,. Chapter 11: Computer integrated sustainable manufacturing. Sustainable Manufacturing Processes. Published Academic Press, Elsevier, Inc.
2. Glancey, J.L. 2011. Vacuum-Based Resin Transfer Molding Techniques for Manufacturing Composite Materials and Components. *Innovations in Materials and Manufacturing Methods*. Abingdon, Oxford, UK.
3. Glancey, J.L. 2003. Machine Design for Vegetable Production Systems, Chapter from *The Encyclopedia of Agricultural, Food and Biological Engineering*, Marcel Dekker, New York, NY.

REFEREED PUBLICATIONS

Journal Articles

1. Alms, J.B., J.L. Glancey, and S.G. Advani. 2011. Liquid composite molding control methodologies using vacuum induced preform relaxation. Composites, Part A. 42(1): 57-65.
2. Cheng, L., A. Thomas, J. L. Glancey, and A.M. Karlsson. 2011. Mechanical behavior of bio-inspired laminated composites. Composites, Part A. 42(2): 211-220.
3. Alms, J.B., J.L. Glancey, and S.G. Advani. 2010. Mechanical properties of composite structures fabricated with the vacuum induced preform relaxation process. Composite Structures 92: 2811–2816.
4. Alms, J.B., L. Garnier, J.L. Glancey, and S.G. Advani. 2010. In-plane permeability characterization of the vacuum infusion processes with fiber relaxation. International Journal of Material Forming 3(2): 1267-1275.
5. Wang, J., J.L. Glancey and J.R. Vinson. 2009. The effects of in-plane shear loads on transverse shear deformations in laminated and sandwich composite panels. Journal of Aircraft, 46(5): 1473-1478.
6. Alms, J.B., A. Catry, J.L. Glancey and S.G. Advani. 2009. Flow modification process for vacuum infusion using port-based resin flow control. SAMPE Journal, 45(2): 54-63.
7. Glancey, J.L., J.T. Sims, and D. Snyder. 2008. Field evaluation of a mechanical topdresser for solid wastes. Biosystems Engineering, 99(3): 432-443.
8. Glancey, J.L., J. Hummel, A. Chirnside, S. Nobles, S. Chanpimol and A. Ravel. 2007. Bio-fuel emission measurements and potential environmental implications for the Mid-Atlantic Region. Journal of Environmental Monitoring and Restoration, 3: 158-166.
9. Keefe, M., J. Glancey, and N. Cloud. 2007. Assessing student team performance in industry-sponsored design projects. Transactions of the ASME, Journal of Mechanical Design, 129(7): 692-700.
10. Brown, D., and J.L. Glancey. 2007. Theoretical and experimental analysis of a continuous blade cutter for leafy vegetables. Transactions of the ASABE, 50(3): 803-813.
11. Nalla, A., M. Fuqua, J.L. Glancey and B. Leleiver. 2007. A multi-segment injection line and real-time adaptive, model-based controller for vacuum assisted resin transfer molding. Composites, Part A: Applied Science and Manufacturing, 38: 1058–1069.
12. Glancey, J., J.T. Sims and D. Snyder. 2007. Agronomic and environmental implications of sidedressed poultry manure as a nitrogen source for crops. Journal of Environmental Monitoring and Restoration, 3: 206-221.
13. Krishnan, M., R. Strosser, J.L. Glancey, and J.Q. Sun. 2006. Adaptive modeling and control of a precision manure spreader. Computers and Electronics in Agriculture, 52(1-2):1-10.
14. Glancey, J.L., W.E. Kee, T.L. Wootten and M. Dukes. 2005. A mechanical harvesting index for horticultural crops. Applied Engineering in Agriculture, 21(4): 555-558.
15. Glancey, J.L., and W.E. Kee. 2005. Engineering aspects of production and mechanization for fresh and processed vegetables. HortTech, 15(1): 76-79.
16. Glancey, J.L., W.E. Kee, and T.L. Wootten. 2005. Technical and strategic advances in vegetable mechanization. HortTech, 15(3): 486-488.
17. Glancey, J.L., R. Strosser, I. Cosden, J. Gordon, M. Dunson, and D. Cook. 2005. A system for the automatic adjustment and control of conditioning roll gap on mower conditioners. SAE Transactions, Journal of Commercial Vehicles, 113(2): 645-650.
18. Wang, J., J.R. Vinson., and J.L. Glancey. 2004. Geometric nonlinear deformation effects in composite sandwich plates subject to in-plane shear loads. Journal of Sandwich Structures and Materials, 6(5): 447-457.
19. Birmingham, A., E. Buzby, D. Davis, E. Benson, J. Glancey, W. Pill, T. Evans, R. Mulrooney, and M. Olszewski. 2004. A precision planter for large seeds in small plots. HortTech, 14(4): 574-576.
20. Keefe, M., J.L. Glancey, and Z. Zhong. 2000. Performance of high oleic soybean oil-based hydraulic fluids in long-duration pump tests. Society of Automotive Engineers Special Publication SP-136, Lubricants for Off-Highway Vehicles.

21. Glancey, J.L., S. Knowlton, E.R. Benson. 1999. Development of a high oleic soybean oil-based hydraulic fluid. SAE Transactions, 107(2): 266-269.
22. Sankula, S., M.J. VanGessel, W.E. Kee and J.L. Glancey. 1999. Impact of row spacing and herbicide rate and application method on weed control and harvest efficiency of lima beans. HortTech, 9(4): 633-637.
23. Kung, L. Jr., A.C. Sheperd, A.M. Smagala, K.M. Endres, C.A. Bessett, N.K. Ranjit, and J.L. Glancey. 1998. The effect of preservatives based on propionic acid on the fermentation and aerobic stability of corn silage and a total mixed ration. Journal of Dairy Science, 81(5): 1322-1330.
24. Glancey, J.L., W.E. Kee, and T.L. Wootten. 1997. Machine harvesting of lima beans for processing. Journal of Vegetable Crop Production. 3: 59–68.
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1. Glancey, J.L. 2009. Mechanical harvesting of several small greens. HortScience, 44(3): 545-554.
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5. Glancey, J.L. and W.E. Kee. 2003. The U.S. Vegetable Industry Past and Future: Technical and Strategic Advances in Mechanization. HortScience, 38(5): 830.

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2. Alms, J., J. Glancey and S. Advani. 2009. Mechanical properties of composite structures made with the vacuum induced preform relaxation process. Proceedings of the American Society for Composites, Twenty-fourth Technical Conference. Newark, DE.
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49. Brown, D., D. Jones, and J.L. Glancey. 2005. Measurement of embryo temperature in incubating avian eggs. NABEC Paper No. 05P008. 2005 NABEC Conference, Lewes, DE.
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51. Konchar, J., J. Glancey, P. Popper. 2005. Sound emission characteristics of new hand-struck tools designed with high performance engineering polymers. NABEC Paper No. 05P007. 2005 NABEC Conference, Lewes, DE.
52. Glancey, J.L., G. Snyder, J. Vinson, J. Krishnan, P. Franklin. Dynamic loading of fiberglass step ladders. NABEC Paper No. Paper No. 05P005. 2005 NABEC Conference, Lewes, DE.
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54. Smith, K., G. Thorson, J.L. Glancey, and S. Huerta. 2005. Real-time surveillance of shallow depth estuaries for water quality and harmful algal blooms. ASCE Paper Number: 40763-7510. 2005 ASCE Watershed Management Conference, Williamsburg, VA.
55. Herseim, R., J.L. Glancey, P. Popper, W. Walker, K. Ranjan, and J. Tretacosta (DuPont, Co.). 2004. Simulation of the mechanics of human falls. ASAE Paper 047026. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.

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75. Glancey, J.L. 1997. Yield monitoring of peas with pod stripper combines. Proceedings of the Biennial Meeting of the Pea Improvement Cooperative, Annapolis, MD.

NON-REFEREED TEACHING PAPERS

1. Glancey, J.L. 2006. Faculty and industry partnerships through sponsored research and design projects targeted to enhance undergraduate education. ASABE Paper No. 068022. ASAE, 2959 Niles Road, St. Joseph, MI 49085-9659.

2. Keefe, M., J.L. Glancey, and N. Cloud. 2005. A case study in assessing team-based design courses that integrate industry-sponsored projects. Paper No. IMECE2005-81756. Proceedings of the 2005 International Mechanical Engineering Congress and Exposition, Orlando, FL

ARTICLES IN THE POPULAR PRESS ABOUT RESEARCH & OUTREACH

1. *USA Today*. Study: Water pollution from poultry farms overestimated. 2013.
2. *The News Journal*. Poultry pollution has been overestimated, UD-led study finds. 2013
3. *The Public Trust Project.* Fowling the Bay?: Media Reports Absolving Poultry Industry of Pollution are Premature. 2013.
4. *NASDA*. Study Shows EPA Overestimates Poultry Pollution in Chesapeake Bay. 2013
5. *The New York Times*. A Long Journey to a Kinder Chisel. February, 2008.
6. *Consumer Reports Magazine*. Exercise and Fitness- Panelists don't see benefit in Soloflex device. July, 2007.
7. *Woodwords on the Brandywine*. Meeting Highlights – New Tool Demonstrations. April, 2007.
8. *Consumer Reports Magazine*. Ladders – some can extend your risk. September, 2006.
9. *DuPont News*. DuPont™ Zytel® Nylon Helps Rejuvenate Hardworking Tool. October, 2006.
10. *The News Journal*. Disabled farmers overcome obstacles. July, 2006
11. *The Vegetable Growers News*. High-tech thumper. Watermelon sensor may put an end to ripeness guessing game. July 1999.
12. *Entrepreneur*. Watermelon ripeness sensor promises savings worldwide. July, 1999.
13. *ScienceDaily*. Watermelon Ripeness Sensor Might Promise Huge Savings For Growers Worldwide. June, 1999.
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15. *Lubricants World*. Development of a high oleic soybean oil-based hydraulic fluid. January, 1999.
16. *Lubes-N-Greases*. Let's Get Small. February, 1997

INVITED PRESENTATIONS

1. Adapting wastewater irrigation for the new Artesian treatment facility in Milton, DE. 2020. Internal meeting at Artesian Water Co., Lewes, DE
2. Equipment handling and mechanical safety for agricultural operations. 2017. The First Annual Delaware Farm Bureau Safety Conference. Harrington, DE
3. Recommended regulatory changes for the Delaware spray-on-demand wastewater distribution program. 2017. Joint meeting of the DNREC and DDA Cabinet Secretaries. (w/ Mayor Ken Branner, Middletown and Scott Hoffman, Duffield Associates). Dover, DE.
4. Changes to the EPA Chesapeake Bay Model inputs for poultry litter nitrogen and phosphorous generation in the bay watershed. 2017. Chesapeake College, Wye, MD.
5. Wastewater treatment and disposal options for small villages and communities. 2016. Joint meeting of the State of Delaware Delegation and the Government of Rengo. Rengo, Chile.
6. Using team-based design projects to build university and industrial partnerships. 2016. Joint meeting of the State of Delaware Delegation and the University of O'Higgins faculty and administration. Rengo, Chile.
7. Reusing treated wastewater for the irrigation of agricultural crops. 2016. Joint meeting of the State of Delaware Delegation and the Government of O'Higgins. Rancagua, Chile.
8. Electrocution and fire hazards outside the poultry house. 2016. Special Poultry Safety Seminar in Honor of Bill Brown. Georgetown, DE.
9. Prediction of NOx and PM emission reductions by converting industrial backup and load shaving generators to Tier 4 diesel engines. 2016. The Delaware Electric Cooperative. Greenwood, DE.
10. Production of N and P from poultry production as part of an overall production mass balance (given by Ed Kee). 2015. Wye Research Center, University of Maryland, MD
11. Updates on the Improved Poultry Data for Modeling the Chesapeake Bay Watershed. 2015. Monthly meeting of the Nutrient Management Commission. Dover, DE.
12. Predicting Poultry N and P generation based on improved estimates for litter concentrations, generation and bird populations. Perdue Agri-Business Orientation Meeting for New Executives. Dover, DE.
13. Comparison of Methods for Estimating Poutry Manure Nutrient Generation in the Chesapeake Bay Watershed. 2014. Meeting of the Northeast Secretaries of Agriculture. Boston, MA.
14. Land application of highly treated municipal wastewater for agricultural uses: Results of a three year pilot project. Scientific and Technical Advisory Committee. 2014. Center for the Inland Bays. University of Delaware, Lewes, DE.

15. Status and timeline for implementing changes to the Chesapeake Bay Watershed Model. EPA Region 3 Headquarters. 2014. Philadelphia, PA
16. The EPA and Chesapeake Bay Program modeling of the Chesapeake Bay Watershed - Deficiencies and Current Efforts to Improve Model Inputs. The International Poultry Production and Processing Expo. 2014. Atlanta, GA. (given by Kelley Shenk, EPA).
17. Status of revised data inputs to the Chesapeake Bay Watershed Model. Chesapeake Bay Regional Poultry Production Data Meeting. 2014. Beltsville, MD.
18. Final recommendations for the Chesapeake Bay Program modeling of the Bay watershed. Chesapeake Bay Program Ag Working Group. 2014. College Park, MD.
19. Proposed recommendations for the Chesapeake Bay Program modeling of the Bay watershed. Chesapeake Bay Program WQGIT. 2014. College Park, MD.
20. Recommendations to improve nitrogen and phosphorous loading from the poultry industry in the Phase 6 Chesapeake Bay Watershed Model. 2014. Center for the Inland Bays. University of Delaware, Lewes, DE.
21. Poultry Litter Subcommittee Update: Status & Updated Summary. Presentation to the EPA Region Ill and Chesapeake Bay Program upper administrations. 2013. Buena Vista, New Castle, DE.
22. Setup and operation of hay balers for optimal hay quality. Delaware Ag Week Technical Sessions. 2014 Harrington, DE.
23. Conditioning options to minimize hay drying time. The Maryland Southern Hay Production Meeting. 2014. Brandywine, MD
24. Updates regarding the Chesapeake Bay Program modeling of the Bay watershed. Chesapeake Bay Program Summit. 2013. College Park, MD.
25. Overview of the Chesapeake Bay Program Modeling of Delmarva – Concerns and current status. The Delaware and Maryland Congressional Delegation’s Poultry Summit. 2012. Delmar, DE. (w/ Secretary Ed Kee and Senators Carper, Coons, Mikulski, Cardin)
26. Comparison of methods for estimating poultry manure nutrient generation in the Chesapeake Bay watershed. 2012. Quarterly meeting of the Chesapeake Bay Program Water Quality Goal Implementation Team. Annapolis, MD.
27. Comparison of University of Delaware and Delaware Department of Agriculture and Environmental Protection Agency Nitrogen and Phosphorous Estimation Methods within the Chesapeake Bay Watershed. Meeting of the Northeast Presidents of Farm Bureau. 2012. Boston MA.
28. Power purchase agreements for large scale industrial businesses. Annual meeting of the Delmarva Poultry Industry. 2012. Ocean City, MD.
29. The Chesapeake Bay Program modeling of the Bay watershed. Meeting of the Northeast Council of Governance. 2012. Atlantic City, NJ.
30. Technical and financial consideration for solar power purchase agreements. Solar work shop for the Delmarva Poultry Industry. 2011. Georgetown, DE.
31. Calculation of assimilation rates for nutrients and heavy metals for as-needed spray irrigation of agricultural crops with treated wastewater. 2011. Monthly meeting of the Bridgeville Town Council. Bridgeville, DE.
32. Updates regarding the Chesapeake Bay Program modeling of the Bay watershed. 2011. Meeting of the Delaware Nutrient Management Commission. Dover, DE.
33. Current estimates for N and P amounts on Delmarva. 2011. Joint meeting of the Delmarva Poultry Association’s Environmental and Grower Committees. Salisbury, MD.
34. Comparison of University of Delaware and Delaware Department of Agriculture and Environmental Protection Agency Nitrogen and Phosphorous Estimation Methods within the Chesapeake Bay Watershed. 2011. Meeting of the Chesapeake Bay Program Ag Working Group. Annapolis, MD.
35. Spray-on-demand with treated and filtered municipal wastewater: Results of a one-year pilot study. 2011. Meeting of the Delaware Nutrient Management Commission. Dover, DE.
36. Nutrient removal methods for Concentrated Animal Feeding Operation runoff. 2010. Chesapeake Goal Line 2025: Opportunities for Enhancing Agricultural Conservation. Hunt Valley, MD.
37. Mechanical systems and automation to enhance the ergonomics of aquaculture. The 2010 Agrability National Training Workshop. Charleston, WV.
38. Feasibility of renewable energy and power purchase agreements for the food manufacturing industry. 2010. The 2010 Pickle Packers International Annual Conference. Philadelphia, PA.
39. An overview of lima bean harvesting research and recommendations. 2009. The Lima Bean Forum. Georgetown, DE.
40. Equipment research at the University of Delaware. 2009. Delegation from the Chinese Consulate, Washington, D.C.

41. Equipment, maintenance, and safety considerations in the installation of on-site waste treatment systems. 2009. The annual meeting of the Delaware On-Site Wastewater Treatment Association. Dover, DE.
42. Design recommendations to improve the safety of portable, metal climbing structures. 2008. The annual meeting of the American National Standards Institute (ANSI), Subcommittee 14.2. Chicago, IL.
43. Machine design in vegetable production and harvesting: A review of 100 years of engineering innovation and design. 2007. The 2007 ASABE International Annual Meeting, Minneapolis, MN.
44. Preventing hand and arm injuries through limited exposure and new low vibration tool technology. 2007 Delaware Safety Association Annual Meeting, Ocean City, MD.
45. Reducing vibration-related injuries from hand and power tools. 2006 National Ergonomics Conference and Exposition. Las Vegas, NV.
46. Ladders – Summary of testing and forensics of failures. 2006. Consumer Union, Inc. Headquarters (Publishers of Consumer Reports Magazine). Yonkers, NY.
47. Measuring the potential for noise and vibration injuries in industrial settings. 2006 Eastern Ergonomics Conference and Exposition. Boston, MA.
48. Assessing and preventing ladder accidents. 2006 Delaware Safety Association Annual Meeting, Ocean City, MD.
49. Demonstration of a new cost effective surveillance system for Delaware water bodies. 2005. Scientific and Technical Advisory Committee, Center for the Inland Bays. University of Delaware, Lewes, DE.
50. Automation requirements for retaining pickling cucumber production in the U.S. 2005 Pickle Packers International Annual Meeting, Baltimore, MD.
51. Developments in harvesting of specialty crops. 2005 AETC Conference, Invited Session on Specialty Crops, Louisville, KY.
52. Barriers to vegetable harvest automation. 2005. AETC Conference, Invited Session on Automation. Louisville, KY.
53. Workshop on hand-arm vibration and noise: Overview of current limits and strategies for reducing working exposure and injury. 2005 Eastern Ergonomics Conference and Exposition, New York, NY.
54. Engineered human protection: An overview of research at University of Delaware. 2004. DuPont Experimental Station, Wilmington, DE.
55. Overview of modern machine designs for mechanized harvest of processing peas. The 2004 ASAE Film Forum. 2004 ASAE International Meeting, Ottawa, Ontario, Canada.
56. Ten years of developments for mechanical harvesting pickling cucumbers. The 2004 ASAE Film Forum. 2004 ASAE International Meeting, Ottawa, Ontario Canada.
57. Theoretical and experimental evaluation of an adaptive controller design using off-line model-based prediction and a segmented injection line for resin flow control in VARTM. 2004. Office of Naval Research, Advanced Materials Intelligent Processing Center (AMIPC). Newark, DE.
58. Progress in developing automated equipment for the simulation of human falls. 2004. DuPont Experimental Station, Wilmington, DE.
59. Improving mold part quality through automation and control: Progress and future challenges. 2004. National Science Foundation Invited Workshop Participant: Future of Modeling in Composites Molding Processes. The National Science Foundation, June 9 and 10, 2004, Alexandria, VA.
60. Progress in spatial and temporal surveillance technology for agricultural and environmental monitoring in Delaware. 2004. Department of Geography, spring 2004 Colloquium. Newark, DE.
61. Design and development of near-real-time whole water column surveillance systems for Delaware estuaries. 2004. Scientific and Technical Advisory Committee, Center for the Inland Bays. College of Marine Studies, University of Delaware, Lewes, DE.
62. Engineering aspects of production and mechanization for fresh and processed vegetables. 2003. Workshop on Recent Advances in Machine Harvesting of Fruits and Vegetables. The 100th Annual International Conference of the American Society for Horticultural Sciences. Providence, Rhode Island
63. Technical and strategic advances in vegetable mechanization. 2003. Colloquium: The U.S. Vegetable Industry Past and Future: Highlighting Advances, Challenges, and Opportunities in Vegetable Crop Management. Proceeding of the 100th Annual International Conference of the American Society for Horticultural Sciences. Providence, Rhode Island (co-presenter with E. Kee).
64. Adaptive control options for liquid composite resin injection. 2002. Office of Naval Research Meeting at the Center for Composite Materials, Newark, DE.
65. Performance of soy-based hydraulic fluids in long-term pump tests. 2001. Annual Meeting of the United Soybean Board Industrial Uses Committee. United Soybean Board, Chicago, IL (co-presenter M. Keefe).
66. Machine harvest: Research and field experiences on Delmarva and production systems, comparative tests of the Raven vs. the PicRyte Harvester, and improving tractor mounted harvesters. 2000. The Pickling Cucumber

Improvement Committee (PCIC) Spring Meeting of the Pickle Packers International, Newark, DE. (E. Kee, J. Glancey and J. Adkins).

67. Current machine design research projects including harvester improvements, automated pale filing, and electronic and digital sorting of pickles. 2000. The Pickling Cucumber Improvement Committee (PCIC) Spring Meeting of the Pickle Packers International, Newark, DE. Demonstrations held on the University of Delaware campus. (Glancey and Kee).
68. Development of a precision manure spreader for improved nutrient management. 1999. Agricultural Computer Expo, Lancaster, PA.
69. Progress in developing a soyoil based hydraulic fluid. 1999. Annual Meeting of the United Soybean Board Industrial Uses Committee. United Soybean Board, Chicago, IL (co-presenter Keefe and J. Gooch (DuPont).
70. Weld design and specifications: An engineer's perspective. 1999. Meeting of the American Welding Society, Delaware Section, Newark, DE.
71. A low volume fluid power test standard for hydraulic fluid testing. 1998. The Lubrizol Corporation, Wickliffe, OH.
72. A soyoil based hydraulic fluid: Advantages and limitations. 1998. United Soybean Board, Chicago, IL, Annual Meeting of the United Soybean Board Industrial Uses Committee (co-presenter S. Knowlton).
73. Mechanical harvesting: Current issues and where should we go from here? 1997. 104th Pickle Packers International Annual Meeting, Las Vegas, NV. (E. Kee presented on my behalf since I could not attend).
74. Progress in cucumber harvester research. 1997. Block and Guggenheimer Foods Inc. Annual Growers Meeting, DuPont Country Club, Seaford, DE.
75. An overview of pod stripper combine research at University of Delaware. 1997. FMC Corporate Headquarters, Chicago, IL.

Research Presentations at Professional Meetings & Conferences

1. Glancey, J., M. Baust, P.E., and E. Kee. Using Treated Municipal Wastewater for Agriculture: A Review of a Pilot Study and Regulations in Delaware. 2015. 2015 NABEC Annual Conference. Newark, DE
2. Glancey, J., B. Brown, E. Kee, M. Davis, L. Towle, Comparison of methods for estimating nutrient generation within the Chesapeake Bay Watershed. 2015. 2015 NABEC Annual Conference. Newark, DE
3. Glancey, J., M. Baust, P.E., B. Carbaugh, E. Kee, and K. Branner. 2011. Using treated municipal wastewater for agriculture: a review of a pilot study and regulations in Delaware. 4th International Symposium on Global Issues in Nutrient Management Science, Technology and Policy. Newark, DE.
4. Glancey, J., B. Brown, E. Kee, M. Davis, L. Towle, J. Timmons, and J. Nelson. 2011. Comparison of methods for estimating poultry manure nutrient generation within the Chesapeake Bay watershed. 4th International Symposium on Global Issues in Nutrient Management Science, Technology and Policy. Newark, DE.
5. Alms, J., J. Glancey and S. Advani. 2009. Mechanical properties of composite structures made with the vacuum induced preform relaxation process. The American Society for Composites, Twenty-fourth Technical Conference. Newark, DE.
6. Brisach, D., J. Alms, J. Glancey and N. Cloud. 2009. Integrated cut performance and sample inspection system for microtome setup evaluation. DETC 2009-87521. The ASME 2009 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, IDETC/CIE 2009. San Diego, CA.
7. Ciappi, R. B. Miller, S. Petfield, C. Uthgenannt, J. Glancey, K. Smith and M. Harkcom. 2009. Design of a protective curtain system for high rotational speed disc mowers. The ASME 2009 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, IDETC/CIE 2009. San Diego, CA.
8. Alms, J., J. Glancey and S. Advani. 2009. Development of computer controlled flow manipulation for vacuum infusion processes. ICCM-17, the International Committee on Composite Materials, Edinburgh, Scotland.
9. Alms, J., J. Glancey and S. Advani. 2009. Sequential injection using a gantry positioning system for flow control in vacuum resin infusion processes. The 2009 Society for the Advancement of Materials and Process Engineering Symposium and Exposition, Baltimore, MD.
10. Alms, J., J. Glancey and S. Advani. 2008. Experimental determination of permeability of woven fiber glass during the vacuum induced preform relaxation (VIPR) process. The 9th International Conference on Textile Composites (TEXCOMP9). Newark, DE.
11. Alms, J., J. Glancey and S. Advani. 2008. Experimental validation of a port based injection methodology for vacuum infusion processes. The 2008 Society for the Advancement of Materials and Process Engineering Symposium and Exposition, Long Beach, CA.

12. Alms, J., J. Glancey and S. Advani. 2008. Vacuum induced preform relaxation (VIPR) process for resin flow control in vacuum infusion processes. The 9th International Conference on Flow Processes in Composite Materials (FPCM-9), July 7th to 9th, Montreal, Quebec, Canada.
13. Collins, S., D. Erickson, S. Mabel, D. Shannon, K. Smith and J. Glancey. 2008. Design and prototyping of a hydraulic hose and cable organizer for mobile equipment. The ASME International Design Engineering Technical Conferences: 5th Symposium on International Design and Design Education (DEC), Brooklyn, NY.
14. Dibelka, J., M. Steimer, L. Traub, J. Twomey, S. Woods, S. Phillips, and J. Glancey, 2008. Design of a heat removal method for the electronics in lithium-ion cordless power tools. The ASME International Design Engineering Technical Conferences: 5th Symposium on International Design and Design Education (DEC), Brooklyn, NY.
15. Glancey, J. 2008. Mechanical harvesting characteristics of several leafy greens grown for processing. The 2008 Northeast Agricultural and Biological Engineering Conference, Annapolis, MD.
16. Pearson, E. J. Woodhouse, B. Miller, R. Strosser and J. Glancey. 2008. Performance of a prototype steer-by-wire driving system for self propelled windrowers. The 2008 Northeast Agricultural and Biological Engineering Conference, Annapolis, MD.
17. Stewart, S., J. Armstrong, J. Harp, D. Breakiron, M. Baker, G. Bennett, R. Jester and J. Glancey. 2008. Mechanical harvesting system for improving the ergonomics for in-door, closed system, live market tilapia production. The 2008 Northeast Agricultural and Biological Engineering Conference, Annapolis, MD.
18. Collins, S., D. Erickson, S. Mabel, D. Shannon, K. Smith and J. Glancey. 2008. A hydraulic hose and electrical cable organizer and support for agricultural implements. The 2008 Northeast Agricultural and Biological Engineering Conference, Annapolis, MD.
19. Alms, J., J. Glancey and S. Advani. 2008. Vacuum induced preform relaxation (VIPR) process for resin flow control in vacuum infusion processes. The American Society for Composites, Twenty-third Technical Conference. Memphis, TN.
20. Glancey. J. 2008. Feasibility of on-site cucumber relish manufacturing from mechanically harvested culled fruit: mechanical and energy requirements. The 2008 ASABE International Annual Meeting. Providence, RI.
21. Glancey, J., R. Gorlich, and R. Jester. 2008. Mechanically-assisted composting of fish mortalities for disabled aquaculture producers. Proceedings of the 2008 ASABE International Annual Meeting. Providence, RI.
22. Fuqua, M. and J. Glancey. 2008. Resin position sensing and control during infusion of composite panels as a cost-effective alternative to metal shielding and panels on agricultural and construction equipment. Proceedings of the 2008 ASABE International Annual Meeting. Providence, RI.
23. Glancey, J., J. Vinson and D. Brisach. 2008. Side rail flexibility and the potential for spreader bar failures on tall step ladders. Proceedings of the 2008 ASABE International Annual Meeting. Providence, RI.
24. Alms, J., J. Glancey and S. Advani. 2008. Vacuum induced preform relaxation (VIPR) process for resin flow control in vacuum infusion processes. The 9th International Conference on Flow Processes in Composite Materials (FPCM-9) will be held from July 7th to 9th 2008, in Montreal, Quebec, Canada.
25. Glancey, J, D. Hoffstetter, and E. Kee. 2008. Impact mechanics of pickling cucumber as a basis for mass flow measurement on mechanical harvesters. Application of Precision Agriculture for Fruits and Vegetables, January 6th – 9th, 2008, Orlando, FL.
26. Alms, J., J. Lawrence, A. Catry, J. Glancey and S. Advani. 2007. Resin delivery and control workstation for VARTM. The Sixth Canadian-International Composites Conference, Winnipeg, Manitoba, Canada.
27. Brisach, D., M. Griffith, J. Konchar, S. Petfield, P. Popper, and J.L. Glancey. 2007. Attenuation of impact and continuous vibration in the hand and arm. The ASME International Design Engineering Technical Conferences: The 21st Biennial Conference on Mechanical Vibration and Noise, & Applications of Vibration and Acoustics in Biomedical Engineering. Las Vegas, NV.
28. Griffith, M., D. Brisach, J. Konchar, S. Petfield, P. Popper, and J.L. Glancey. 2007. Polymer-based vibration and noise emission control characteristics for hand-struck tools. The ASME International Design Engineering Technical Conferences: The 19th Reliability, Stress Analysis and Failure Prevention Conference, Las Vegas, NV.
29. Stewart, S., J. Armstrong, R. Jester and J. Glancey. 2007. A bulk mechanical harvester for indoor, closed system tilipia production. The 4th National Aquaculture Extension Conference, Cincinnati, OH.
30. Brisach, D., M. Griffith, J. Konchar, P. Popper, and J. Glancey. 2007. Polymer composite-based noise emission controls for power and hand-struck impact tools. The 2007 American Industrial Hygiene Conference & Exposition, Philadelphia, PA.
31. Griffith, M., D. Brisach, J. Konchar, J. Nasr, P. Popper, and J. Glancey. 2007. Reducing the potential for vibration-related injuries from hand and power tools. The 2007 American Industrial Hygiene Conference & Exposition, Philadelphia, PA.

32. Glancey, J.L., J. Hummel, A. Chirnside, S. Nobles, S. Chanpimol and A. Ravel. 2007. Bio-fuel emission measurements and potential environmental implications for the Mid-Atlantic Region. National Conference on Agriculture & Natural Resource Conservation and Management. Dover, DE.
33. Smith, K., J. Glancey, S. Huerta, E. Humphries and R. Tyler. 2007. Cost effective, real-time surveillance of shallow depth estuaries for water quality monitoring and harmful algal bloom detection. National Conference on Agriculture & Natural Resource Conservation and Management. Dover, DE.
34. Glancey, J., J.T. Sims and D. Snyder. 2007. Field evaluation of new sidedressing technology for side dressing solid wastes. National Conference on Agriculture & Natural Resource Conservation and Management. Dover, DE.
35. Fuqua, M. and J.L. Glancey. 2007. The Effects of in-tool resin delivery ports on process control and molded part quality for vacuum-based composite manufacturing. The Greater Philadelphia AIAA/ASME 3rd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
36. Nasr, J., M. Fuqua, S. Kasprzak, and J. Glancey. 2007. Modeling and experimental validation of an external flooding chamber for vacuum-based composite molding. The Greater Philadelphia AIAA/ASME 3rd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
37. Brisach, D., M. Griffith, S. Petfield, P. Popper, and J. Glancey. 2007. Evaluation of reinforced polymer composites for engineering controls of sound and vibration. The Greater Philadelphia AIAA/ASME 3rd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
38. Alms, J., S. Advani, and J. Glancey. 2007. Vacuum induced preform relaxation (VIPR) method for liquid composite molding (LCM) processes. The Greater Philadelphia AIAA/ASME 3rd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
39. Konchar, J., D. Brisach, M. Griffith, J. Nasr, P. Popper, and J. Glancey. 2007. Design and testing of composite driveline components for impact tools. The 2007 Society for the Advancement of Materials and Process Engineering Symposium and Exposition, Baltimore, MD.
40. Kasprzak, S., J. Nasr, M. Fuqua, and J. Glancey. 2007. An external flow modification system for vacuum-assisted resin transfer molding. The 2007 Society for the Advancement of Materials and Process Engineering Symposium and Exposition, Baltimore, MD.
41. Fuqua, M. and J. Glancey. 2007. Design and performance of a closed loop control, port-based resin delivery system for vacuum-assisted resin transfer molding. The 2007 Society for the Advancement of materials and process engineering symposium and exposition, Baltimore, MD.
42. Glancey, J.L., J. Hummel, S. Nobles, S. Chanpimol, and A. Raval. 2007. Measurement of transient smoke emissions characteristics from e-diesel and soy-diesel fuel blends in two commercial engines. The 2007 ASABE International Annual Meeting, Minneapolis, MN.
43. Glancey, J.L. 2007. Once-over harvesting of several leafy greens. The 2007 ASABE International Annual Meeting, Minneapolis, MN.
44. Brisach, D., M. Griffith, P. Popper and J. Glancey. 2007. Measurement of vibration transmission in the hand and arm from impact and continuous vibrating sources. The 2007 ASABE International Annual Meeting, Minneapolis, MN.
45. Glancey, J.L., and D. Brown. 2007. Mechanical harvesting of spinach. Northeast Region of the American Society for Horticultural Science, University of Maryland, College Park, MD.
46. Glancey, J.L. 2007. Yield, plant architecture, and machine harvest characteristics of several leafy greens grown for processing. Northeast Region of the American Society for Horticultural Science, University of Maryland, College Park, MD.
47. Fuqua, M. and J.L. Glancey. 2006. A port injection process for improved resin delivery and flow control in vacuum-assisted resin transfer molded composites. 2006 ASME International Annual Meeting, Chicago, IL.
48. Konchar, J., P. M. Griffith, P. Popper, and J.L. Glancey. 2006. Modeling and testing of a new polymer-based impact tool design to reduce biomechanical injuries. 2006 ASME International Annual Meeting, Chicago, IL.
49. Kasprzak, S., M. Fuqua., J. Nasr, and J.L. Glancey. 2006. A robotic system for real-time resin flow modification during vacuum-assisted resin transfer molding of composite materials. 2006 ASME International Annual Meeting, Chicago, IL.
50. Brown, D. and J.L. Glancey. 2006. Fatigue and stability analysis of long-span continuous band saw blades. 2006 ASME International Annual Meeting, Chicago, IL.
51. Griffith, M., J. Nasr, P. Popper, and J.L. Glancey. 2006. A reinforced polymer hammer cap for eliminating metal-to-metal contact and reducing hand-transmitted vibration. 2006 ASABE International Annual Meeting, Portland, OR.
52. Brown, D., and J.L. Glancey. 2006. Fatigue analysis and testing of a continuous blade band-type cutter for leafy vegetables. 2006 ASABE International Annual Meeting, Portland, OR.

53. Armstrong, J., G. Stewart, J. Harp, D. Breakiron, M. Baker, G. Bennett, R. Jester, and J. Glancey. 2006. Improving the ergonomics of harvest for pond raised live market tilapia. 2006 ASABE International Annual Meeting, Portland, OR.
54. Fuqua, M. and J.L. Glancey. 2006. Development of a port injection process for vacuum assisted resin transfer molding. The 2006 Meeting of the Society for the Advancement of Materials and Processes (SAMPE), Long Beach, CA.
55. Fuqua and Glancey. 2006. Modeling of vacuum-assisted resin transfer with in-mold ports. The Greater Philadelphia AIAA/ASME 2nd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
56. Nasr, J., S. Kasprzak, and J. Glancey. 2006. External modification of VARTM flow with a rigid external chamber. The Greater Philadelphia AIAA/ASME 2nd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
57. Kasprzak, S., M. Fuqua, J. Nasr, and J.L. Glancey. 2006. A real-time resin flow modification robot for vacuum-assisted resin transfer molding of composite materials. The Greater Philadelphia AIAA/ASME 2nd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
58. Nalla, A. and J. Glancey. 2006. Adaptive, model-based control for resin transfer molding. The Greater Philadelphia AIAA/ASME 2nd Annual Aerospace & Mechanical Engineering Mini-Symposium. Plymouth Meeting, PA.
59. Konchar, J. and J. Glancey. 2006. Molding and testing of composite-based impact tool designs to reduced biomechanical injuries. The 3rd Annual Center for Biomedical Engineering Research Symposium, Newark, DE.
60. Nalla, A. and J.L. Glancey. 2005. Closed loop control of resin flow in VARTM using a multi-segment injection line and real-time adaptive, model-based control. The 2005 ASME International Mechanical Engineering Congress and R&D Expo, Orlando, FL.
61. Stewart, S., J. Armstrong, J. Harp, D. Breakiron, M. Baker, G. Bennett, R. Jester and J. Glancey. 2005. Mechanical harvesting aids for indoor, closed system tilapia production. 2005 National Agrability Conference, Burlington, VT.
62. Glancey, J.L. 2005. Design and performance of a hydro-unloading system for machine harvested vegetables. 2005 ASAE International Annual Meeting, Orlando, FL.
63. Glancey, J.L., J. R. Vinson, and G. A. Snyder. 2005. Assessing ladder accidents. 2005 ASAE International Annual Meeting, Orlando, Florida.
64. Glancey, J.L., P. Popper, and J. Konchar. 2005. Ergonomic benefits of polymer capped chisels. 2005 ASAE International Annual Meeting, Orlando, FL.
65. Glancey, J.L., K. Carlisle, and W. Carlisle. 2005. High speed mechanical harvesting of spinach. 2005 NABEC Conference, Lewes, DE.
66. Kasprzak, S., M. Fuqua, M. Griffith, J. Nasr, and J. L. Glancey. 2005. An overview of composite manufacturing processes and applications. 2005 NABEC Conference, Lewes, DE.
67. Meckley, D., K. Smith, E. Priepke, and J. Glancey. 2005. A hydraulic powered bale kicker for large round balers. 2005 NABEC Conference, Lewes, DE.
68. Dickerson, D., R. Benetiz, M. Baker, G. VanWicklen and J.L. Glancey. 2005. Automated testing of poultry nipple drinkers. 2005 NABEC Conference, Lewes, DE.
69. Brown, D., D. Jones, and J.L. Glancey. 2005. Measurement of embryo temperature in incubating avian eggs. 2005 NABEC Conference, Lewes, DE.
70. Herseim, R., K. Comer, T. Stiefvater, and J. Glancey. Structural analysis and testing of injected molded plastic drive train shields for self-propelled mower conditioners. 2005 NABEC Conference, Lewes, DE.
71. Sims, J.T., J.L. Glancey, and D. Snyder. 2005. Field Evaluation of an applicator for sidedressing row crops with solid wastes. 2005 NABEC Conference, Lewes, DE.
72. Konchar, J., J. Glancey, P. Popper. 2005. Sound emission characteristics of new hand-struck tools designed with high performance engineering polymers. 2005 NABEC Conference, Lewes, DE.
73. Glancey, J.L., G. Snyder, J. Vinson, J. Krishnan, P. Franklin. Dynamic loading of fiberglass step ladders. 2005 NABEC Conference, Lewes, DE.
74. Glancey, J.L., R. Strosser, I. Cosden, M. Dunson, J. Gordon, and D. Cook. 2005. Automatic adjustment and control of the conditioning roll gap on mower-conditioners. 2005 NABEC Conference, Lewes, DE.
75. Lynch, S., W. F. Ritter, and J. Glancey. 2005. Potential economic impacts of the biodiesel industry in Delaware. 2005 NABEC Conference, Lewes, DE.
76. Smith, K., G. Thorson, J.L. Glancey, and S.Huerta. 2005. Real-time surveillance of shallow depth estuaries for water quality and harmful algal blooms. 2005 ASCE Watershed Management Conference, Williamsburg, VA.

77. Konchar, J. and J. L. Glancey. 2005. Strategies for reducing hearing loss in industrial workers. 2nd Annual Center for Biomedical Engineering Research Symposium, Newark, DE.
78. Krisher, J. and J.L. Glancey. 2005. Modeling the impact of human falls. 2nd Annual Center for Biomedical Engineering Research Symposium, Newark, DE.
79. Glancey, J. L., R. Strosser, I. Cosden, J. Gordon, M. Dunson, and D. Cook. 2004. A system for the automatic adjustment and control of the conditioning roll gap on mower-conditioners. 2004 Society of Automotive Engineers Commercial Vehicle Engineering Congress, Advances in Off-Road Vehicle Electronics. Chicago, IL.
80. Vinson, J., J. L. Glancey, and G. A. Snyder. 2004. Analysis, design and optimization of high performance composite sandwich water skis. The 2004 ASME International Mechanical Engineering Congress and R&D Expo, Los Angeles, CA. (presented by J. Vinson).
81. Smith, K. and J. L. Glancey. 2004. Design and testing of a low-cost whole water column, near-real-time surveillance device for shallow depth estuaries. 2004 ASAE International Meeting, Ottawa, Ontario, Canada.
82. Glancey, J.L., W.E. Kee, and T.L. Wootten. 2004. Effects of plant architecture on the mechanical recovery of bush-type vegetable crops. 2004 ASAE International Meeting, Ottawa, Ontario, Canada.
83. Glancey, J.L. and T. Nasr. 2004. Measurement of transmitted vibration in tools designed using engineering polymers. 2004 ASAE International Meeting, Ottawa, Ontario, Canada.
84. Herseim, R., J.L. Glancey, P. Popper, W. Walker, K. Ranjan, and J. Tretacosta (DuPont, Co.). 2004. A device to simulate the mechanics of human falls. 2004 ASAE International Meeting, Ottawa, Ontario, Canada.
85. Herseim, R., J. Moore, and J. L. Glancey. 2004. An instrumented device for measuring the dynamics of human falls. 2004 Northeast Region Ag and Biological Engineers, State College, PA.
86. Smith, K., G. Thorson, and J. L. Glancey. 2004. Progress in developing low cost, near-real-time surveillance systems for water quality monitoring in Delaware. 2004 Northeast Region Ag and Biological Engineers, State College, PA.
87. Nalla, A., J.L. Glancey and B. Leleiver. 2004. Theoretical and experimental evaluation of a segmented injection line for resin flow control in VARTM. The 7th International Conference on Flow Processes in Composite Materials, USA, 7 ~ 9 July, Newark, DE..
88. Nalla, A., B. Leleiver, and J.L. Glancey. 2004. Design and performance of a new VARTM resin injection line. The 7th International Conference on Flow Processes in Composite Materials, 7 ~ 9 July, 2004, Newark, DE.
89. Moore, J., J. Lawrence, and J.L. Glancey. 2004. A test stand and standard testing methodology for measuring the hand-arm vibration characteristics of power tools. 2004 University of Delaware Center for Biomedical Engineering Research Symposium, Newark, DE.
90. Muhlenforth, D., D. Schiavoni, and J. L. Glancey. 2004. Spectral analysis of new, low vibration hand-struck tool designs. 2004 University of Delaware Center for Biomedical Engineering Research Symposium, Newark, DE.
91. Herseim, R. and J. L. Glancey. 2004. The mechanics of human falls. 1st Annual Center for Biomedical Engineering Research Symposium, Newark, DE.
92. Tuday, B., J. Fitzgibbons, S. Davidson, and J. L. Glancey. 2004. Design requirements for an automated measurement system for the evaluation of progress during hand and finger physical therapy. 2004 University of Delaware Center for Biomedical Engineering Research Symposium, Newark, DE.
93. Humphries, E. (Delaware Department of Natural Resources and Environmental Control - DNREC), et. al. (DNREC presenter on behalf of all University of Delaware and DNREC researchers). 2003. State of Delaware 2003 harmful algae bloom initiative- summary of current research and partners. 2nd Symposium on Harmful Marine Algae in the U.S., Woods Hole, MA.
94. Glancey, J.L., G.A. Snyder (National Forensic Engineers, Inc.), and J.R. Vinson. 2003. Experimental evaluation of the structural characteristics of extruded aluminum stepladders. The ASME International Design Engineering Technical Conferences: 17th Reliability, Stress Analysis and Failure Prevention Conference, Chicago, IL.
95. Snyder, G.A. (National Forensic Engineers, Inc.), J.L. Glancey, and J.R. Vinson. 2003. Failure analysis of stepladders manufactured from extruded aluminum. The 2003 ASME International Mechanical Engineering Congress and R&D Expo, Washington, D.C.
96. Glancey, J.L., P. Popper, M. Mitch, P. Truitt, T. Nasr, M. Orgovan, J. Stevens. 2003. A new cyclic impact device and standard testing methodology for hand struck tools. The 2003 ASME International Mechanical Engineering Congress and R&D Expo, Washington, D.C.
97. Glancey, J.L., P. Popper, T. Nasr, P. Truitt, M. Orgovan, D. O'Brian. 2003. Design and performance of hand-struck impact tools using high performance polymers. The 2003 ASME International Annual Meeting, Washington, D.C.
98. Wang, J., J.L. Glancey, and J.R. Vinson. 2002. Transverse shear deformation effects in laminated and sandwich composite panels subjected to in-plane shear. ASME IMECE, New Orleans, LA.

99. Wang , J., J.R. Vinson., and J.L. Glancey. 2002. Geometric nonlinear deformation effects in composite sandwich plates subject to in-plane shear loads ASME IMECE, New Orleans, LA.
100. Glancey, J. L. 2001. Digital signal processing of the storage bin mass on mobile equipment for the prediction of crop mass flow rate and yield. The 2001 ASAE International Annual Meeting, Sacramento, CA.
101. Keefe, M., J.L. Glancey, and Z. Zhong. 2000. Performance of high oleic soybean oil-based hydraulic fluids in long-duration pump tests. The 2000 International Off-Highway & Powerplant Congress & Exposition. Milwaukee, WI.
102. Krishnan, M., R. Strosser, J.L. Glancey and J.Q. Sun. 2000. Adaptive modeling and control of precision agricultural machines. The 2000 International Off-Highway & Powerplant Congress & Exposition. Milwaukee, WI.
103. Glancey, J.L., S. Knowlton, E.R. Benson. 1999. Development of a high oleic soybean oil-based hydraulic fluid. The 1998 International Off-Highway & Powerplant Congress & Exposition. Milwaukee, WI.
104. Glancey, J.L., J.K. Rosenberger, and S.S. Cloud. 1999. Measurement of embryo and air cell temperatures in incubating broiler eggs. Abstract #9938. The 10th Annual Northeast Agricultural and Biological Engineering Conference, Lancaster, PA.
105. Knowlton, S (DuPont), and J.L. Glancey. 1998. Development of a high oleic soybean oil-based hydraulic fluid. 1998. The 89th Annual Meeting of the American Oil Chemists Society. May 1998, Chicago, IL.
106. Glancey, J.L., D.W. Hofstetter, W.E. Kee and T.L. Wootten. 1998. Yield and soil property variations in processed vegetable production on the Delmarva Peninsula. The 1998 ASAE International Annual Meeting. Orlando, FL.
107. Glancey, J.L., W.E. Kee, T.L. Wootten and D.W. Hofstetter. 1998. Feasibility of once-over mechanical harvest of processing squash. The 1998 ASAE International Annual Meeting. Orlando, FL.
108. Glancey, J.L., D. Hoffstetter, W.E. Kee, T.L. Wootten, and M. Lynch. 1997. Preliminary evaluation of yield monitoring techniques for vegetables. 1997 ASAE International Annual Meeting, Minneapolis, MN.
109. Glancey, J.L., S. Seymour, C. Bohman, R. Sheehan, and J. Posselius (New Holland, Inc.). 1997. Development of a precision industrial spreader for the land application of solid wastes. 1997 ASAE International Annual Meeting, Minneapolis, MN.
110. Glancey, J.L., W.E. Kee, and T.L. Wootten. 1997. Reducing damage and improving recovery of mechanically harvested pickling cucumbers. 1997 ASAE International Annual Meeting, Minneapolis, MN.
111. Glancey, J.L., W.E. Kee, T.L. Wootten. 1997. Modeling recovery of pod stripper combines used for the mechanical harvesting of processed vegetables. The 5th International Symposium on Fruit, Nut and Vegetable Production Engineering. Davis, CA.
112. Kee, W.E., T.L. Wootten and J.L. Glancey. 1997. Production systems to optimize mechanical harvest of pickling cucumbers. The 5th International Symposium on Fruit, Nut and Vegetable Production Engineering. Davis, CA.
113. Glancey, J.L. 1997. Yield monitoring techniques for lima beans harvested with pod stripper combines. The Biennial Meeting of the Bean Improvement Cooperative, Annapolis, MD.
114. Glancey, J.L. 1997. Yield monitoring of peas with pod stripper combines. The Biennial Meeting of the Pea Improvement Cooperative, Annapolis, MD.

Teaching Presentations at Professional Meetings & Conferences

1. Glancey, J.L. 2006. Faculty and industry partnerships through sponsored research and design projects targeted to enhance undergraduate education. The 2006 ASABE International Annual Meeting, Seattle, WA.
2. Keefe, M., J.L. Glancey, and N. Cloud. 2005. A Case Study In Assessing Team-Based Design Courses That Integrate Industry-Sponsored Projects. The 2005 International Mechanical Engineering Congress and Exposition, Orlando, FL.

Funded Research Projects

1. Developing Irrigation BMP’s for Spray on Demand with Municipal Wastewater. Delaware Department of Agriculture and Delaware Department of Natural Resources and Environmental Control. 2010-11.
2. Advanced Materials Manufacturing: Rapid Tooling for Large Scale Composite Structures-Phase I. Gillespie, Advani, et.al. Office of Naval Research. 2009-11.
3. Advanced Materials Intelligent Processing-Phase VI. Gillespie, Advani, Weile, Glancey, and Panchapakesan. Office of Naval Research. 2003-05. $1,025,000.
4. Development of Near-Real-Time Whole Water Column Surveillance Technology for Shallow Depth Estuaries. Delaware Department of Natural Resources and Environmental Control, and The Center for the Inland Bays - $30,500, and University of Delaware, College of Agriculture and Natural Resources Research Match - $29,500.

5. Advanced Materials Intelligent Processing-Phase V. Gillespie, Advani, Weile, Glancey, and Panchapakesan. Office of Naval Research. 2003-04. $1,300,000.
6. Development of Hip-Impact Simulation Device. 2003- present. DuPont, Inc. $22,000.
7. Improving Hand and Power Impact Tool Performance with Engineering Polymers. 2003-04. Hard Hat, LCC. $9,000.
8. Feasibility of Automation for Medical Sensor Manufacturing Inspections. 2003. Dade Behring, Glasgow, DE. $5,000.
9. Propulsion Control for the New Holland Power Units. 2002-03. New Holland, NA, New Holland, PA. $10,000. (with J.Q. Sun).
10. Improving Performance of Commercial Avian Incubators through Innovative Measurement and Control of Embryo Temperature. 2002-04. U.S. Poultry and Egg Association. $48,000.
11. Advanced Materials Intelligent Processing- Phase IV. 2002-03. Gillespie, Advani, Weile, Glancey, and Panchapakesan. Office of Naval Research. $1,300,000.
12. Design of a Solar House for the Solar Decathlon Competition. 2001. U.S. Dept. of Energy (co-investigator w/ L.P. Wang and A.J. Prasad). $5,000.
13. Adaptive Controls for New Holland Demeter Machines. 2000-2002. CNH Global - Haytools $20,000. (with J.Q. Sun).
14. Chemical Analysis of Used High Oleic Soyoil Hydraulic Fluid. 2001. DuPont. $20,000 (with M. Keefe).
15. Preliminary Control, Analysis and Design of New Holland Demeter Machines. 2000. CNH Global - Haytools $8,000 (Co-investigator w/ Jian Sun).
16. Gift from Pickle Packers International. 1999. $5,000. (E. Kee and J. Glancey).
17. Testing Soyoil-Based Hydraulic Fluids. 1999-2001. The United Soybean Board $25,000. DRP $25,000. (Joint project with DuPont, M. Keefe and A. Szeri).
18. Noise Reduction on the New Holland Skid Loader. 1999. New Holland, N.A., Inc. $20,000 (2nd investigator with Jian Sun).
19. Demonstration of Improved Configurations for Cucumbers Harvesters. 1998-99. Delaware Vegetable Growers Check-Off: $22,000; and the Delaware Research Partnership: $22,000.
20. Calibration of a Microwave Yield Sensor. 1999. New Holland N.A., Inc. $6,000.
21. Development of a Phosphorous-Index for the Management of Fertilizer and Poultry Manure P. 1999-2001. $50,000 (Delaware Department of Natural Resources and Environmental Control - DNREC, the State of Maryland). (J.T. Sims, Principle Investigator).
22. Development of a High Oleic Soybean Oil-Based Hydraulic Fluid. 1997-1999. DuPont: $45,000; and the Delaware Research Partnership: $32,000
23. Development of a Precision Industrial Spreader. 1997-98. DNREC: $39,500, New Holland, N.A., Inc.: $49,000.
24. Mechanical Harvester Improvement Program. 1997-2001. Pickle Packers International, Inc. $20,000. (with Ed Kee).

INTELLECTUAL PROPERTY

- <u>Patents Awarded</u>
  1. *System and Method for Controlling Permeability in Vacuum Infusion Processes.* U.S. Patent No. 9,079,367. 2015.
  2. *Computer Controlled Flow Manipulation for Vacuum Infusion Processes.* U.S. Patent No. 8,808,612. 2014
  3. *Apparatus and Method for Preform Relaxation and Flow Control in Liquid Composite Molding Processes.* U.S. Patent No. 8,210,841. 2012.
  4. *An Automatic Control System for Vegetable Harvesters.* U.S. Patent No. 5,784,871. 1999.

- <u>Provisional Patents, and Patent Applications Submitted and/or Under Review at the U.S. Patent Office</u>
  1. *A Method for Separating Oil from Water*. U.S. Provisional Patent No. 61/370,067.
  2. *Apparatus and System for Magnetically Controlling Permeability in a Vacuum Infusion Process*. U.S. Provisional Patent No. 61/376,893.
  3. *Twist-Lock Mechanism for Attaching Composite Impact Surfaces to Impact Tools.* U.S. Provisional Patent No. 61/255.331.
  4. *Combination of Impact Tool Cap and Shaped Relatively Low Modulus Material*. U.S. Patent Application No. 12/083903.
  5. *A Functional Polymer Faced Hammer for Reduced Vibration, Noise, and Improved Ergonomics*. U.S. Patent Application No. WO 2007/082238.

6. *Snap-off Blade Knife with Safety Stop*. U.S. Patent Application No. 12/509085
7. *Vacuum Assisted Resin Transfer Molding Techniques with Flood Flow Chamber for Composite Material Manufacturing.* U.S. Patent Application No. 11/458122.
8. *A Low Volume Testing Device to Evaluate Hydraulic Fluid Performance*. U.S. Patent Application No. 09/256,060. (patent application withdrawn by UD).
9. *Direct, Continuous Measurement of the Mass Flow Rate of Bulk Materials*. U.S. Provisional Patent Application No. 60/094,543.

- Additional Invention Disclosures and Applications

10. *A High Oleic Soybean Oil-Based Biodegradable, Non-Toxic Hydraulic Fluid*. (Provisional Patent submitted by DuPont).
11. *An Applicator for Metering Bulk Solid Wastes and Compost in Rows.* (Provisional Patent submitted by New Holland, Inc. N.A.).

PROFESSIONAL CONSULTING

- Expert Witness – *Deposition & Court Testimony*

1. *Mussumecci v. Werner Co.*, Case No. HNT-L-642-02 (Superior Court of New Jersey) (deposition and court appearance)
2. *Kasper v. Tricam Industries, Inc., Walgreen Company, and Home Depot, Inc.*, Case No. 05 L 0001444 (Circuit Court of Cook County, Illinois) (deposition);
3. *Arancibia v. Core Distribution, Inc. and Home Depot U.S.A., Inc*., Case No. 10-CV-05807-ADS-AKT (District Court of New York, Eastern District) (deposition);
4. *Abbate v. Werner Company and Home Depot U.S.A., Inc.*, C/A No. 09C-02-013 (Superior Court of Delaware) (deposition);
5. *Kahn v. Macklanburn-Duncan Company*, C/A No. 07-CP-1512 (Common Pleas 14th Judicial Court of South Carolina) (deposition);
6. *Bethea v. S.P. Richards & SDI Corporation*, Case No. 4:06-CV-2604-TLW-TER (District of South Carolina, Florence Division), (deposition)
7. *Uli v. Lowe's HIW, Inc.*, Case No. 34-2009-00038666 (Superior Court of California, County of Sacramento); (deposition)
8. *Ford v. Werner Company and Home Depot U.S.A., Inc.*, Case No. ED CV 05-00988 SGL (District of California, Eastern Division), (deposition and court appearance);
9. *Campos v. Louisville Ladder, Inc.*, Civil Action No. C-09-39 Jury, (Southern District of Texas, Corpus Christi Division) (deposition);
10. *Flores v. Lynn Ladder & Scaffolding Co., Inc., Capital Rental Inc., and TCR Mid-Atlantic Construction*, Law No. CL06-5310 (Circuit Court of Fairfax, Virginia), (deposition and court appearance);
11. *Chenault et al. v. Doral Industries Inc., Costco Home & Office Products Inc., Walmart Stores Inc., and Sam's Club*, Case No. 1:08-cv-00354-SS (Western District of Texas, Austin Division) (deposition and court appearance);
12. *Yoder et al. v. The Sportsman's Guide, Inc.*, No. 14-cv-00937 (Western District of Pennsylvania) (deposition);
13. *Fitzner v. New Werner Holding Co., Inc. et al.*, No. SX-09-cv-400 (Superior Court of the Virgin Islands) (deposition);
14. *Foster v. Tricam Industries & Home Depot U.S.A., Inc.*, No. 11-cv-00338 (District of Utah) (deposition and court appearance);
15. *Leach v. Core Distribution, Inc. et al.*, No. 10-cv-02570 (District of Colorado) (deposition and court appearance);
16. *Jackson v. Louisville Ladder, Inc. et al.*, No. 11-cv-1527 (Middle District of Pennsylvania) (deposition and court appearance);
17. *Hodge v. Louisville Ladder, Inc. et al.*, No. 12-cv-00240 (Southern District of Texas) (deposition and court appearance);
18. *Picken v. Cuprum S.A. de C.V. et al.*, No. 11-13044 (Eastern District of Michigan) (deposition and court appearance);
19. *Ash v. Reber & Reber (3rd Party Plaintiff) v. Tricam Industries et al.*, No. 145499/2012 (Supreme Court Niagara County, New York) (deposition and court appearance);
20. *Coon v. NK Co. Ltd. et al.*, No. UNN-L-1809-10 (Union County Superior Court, New Jersey) (deposition and court appearance);
21. *Privado v. Vestil Manufacturing Corporation*, No. 7:16-cv-00649 (Southern District of Texas) (deposition);

22. *Privado v. AIM Media Texas Operating, LLC*, No. JWA NO. 994-A 2016 (Southern District of Texas), (deposition);
23. *Bocelli v. Owens & Minor Distribution Inc. and Crown Equipment Corp.*, No. 2:15-cv-06313-NIQA (Eastern District of Pennsylvania) (deposition);
24. *Blackbird Technologies LLC v. Lenovo PC International*, C.A. No. 16-140-RGA (District Court for the District of Delaware) (deposition);
25. *Deem v. Barnett Outdoors, LLC*, C.A. 5:18-cv-582 (District Court for the Western District of Texas, San Antonio Division) (deposition);
26. *Lopez v. RGV Lava-wash Cleaning Services, LLC.* CASE NO. C-2151-18-D. (District Court for the Western District of Texas, San Antonio Division) (deposition);
27. *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants).* C.A. No. 18-827-CFC. (U.S. Patent and Trademark Office). IPR of Patents 8,813,663 & 9,861,031. Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition);
28. *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants).* C.A. No. 18-827-CFC. (U.S. Patent and Trademark Office). IPR of Patents 9,699,955 & 10,004,173. Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition);
29. *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants).* C.A. No. 18-827-CFC. (U.S. Patent and Trademark Office). IPR of Patents 9,807,922 & 9,480,199. Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition);
30. *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants).* C.A. No. 18-827-CFC. (U.S. Patent and Trademark Office). IPR of Patents 9,686,906 & 9,807,924. Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition);
31. *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants).* C.A. No. 18-827-CFC. (U.S. Patent and Trademark Office). IPR of Patent 9,820,429. Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition);
32. *Steuben Foods, Inc. (Plaintiff) vs. Shibuua Hoppman, LLC. and HP Hood LLC (Defendants).* Case No. CV-00781-WMS-JJM. (District Court for Delaware). U.S. Patent Numbers: 6,209,591, 6,536,188 and 6,702,985. Defendant Attorney: Byron Pickard, Sterne, Kessler, Goldstein & Fox P.L.L.C., Washington, D.C. (deposition and trial);
33. *Juki America, Inc. et al. (Plaintiff). vs. ABM International, Inc. (Defendant).* Case No. IPR2020-01371, -01372, and -01373). Inter Partes Review Expert in front of the Patent Trial and Appeals Board for U.S. Patent Numbers: 9,840,797, 10,100,449, and 10,240,270. Defendant attorney: Mike Berchou, Harter Secrest & Emery LLP, Buffalo, NY (deposition);
34. *Unverferth Manufacturing Co., Inc. (Plaintiff) vs. Meridian Manufacturing Corp. (Defendant).* Case No. 5:19-cv-4005. (District Court for Iowa). Infringement of Agricultural Seed Carrier with Pivoting Conveyor, U.S. Patent Numbers: 8,221,047, 8,967,940, and 9,745,123. Working on behalf of the Plaintiff. Plaintiff Attorney: Joseph Hines, Esq., Rothwell Figg, Washington, D.C. (deposition).
35. *Clayton (Plaintiff) vs. Heil Company, Inc. (Defendant).* Case No. CV-19-04724-PHX-GMS. (District Court for Arizona). Plaintiff Attorney: John E. Osborne, Esq. Goldberg & Osborne LLP. Tucson, AZ. (deposition);
36. *Olati LLC (Plaintiff) v Hass Automation (Defendant)*. Case No. IPR2021-00146. (District Court Central for California Western Division). Inter Partes Review Expert in front of the Patent Trial and Appeals Board for U.S. Patent Number 8,136,432. Working on behalf of the Plaintiff. Plaintiff Attorney: Matt Holohan, Esq., Sheridan Ross, PC., Denver, CO. (deposition);
37. *Kamm (Plaintiff) vs. Stellar, et al. (Defendant).* Case No. CV-19-05172-PHX-SPL. (District Court for Arizona). Working on behalf of the Plaintiff. Plaintiff Attorney: Matt Holohan, Esq., Sheridan Ross, PC., Denver, CO. (Deposition);
38. *John Deere (Plaintiff) v AGCO and Precision Planting (Defendants). C.A. No. 18-827 (CFC) (Consolidated).* District Court of Delaware. Infringement of Plaintiff Patents 8813663 and 9699955. Working on behalf of Plaintiff Attorney: Jay Alexander, Covington and Burling, Washington, D.C. (deposition and trial);
39. *Palmer (Plaintiff) v Stanley Black and Decker (Defendant).* Case No. 20-cv-1084. (Middle District Court of Pennsylvania). Working on behalf of the Plaintiff. Plaintiff Attorney: Wayne Marvel Esq., Maron, Marvel, Bradley, Anderson, & Tardy LLC. Wilmington, DE. (trial only).

40. *Pentz (Plaintiff) vs. Werner Ladder (Defendant).* Civil No. 210900435. Working on behalf of the Plaintiff District Court of Utah. Plaintiff Attorney: Douglas B. Cannon, Esq., Fabian & Clenndenin, P.C., Salt Lake City, UT. (deposition).
41. *Parents of the Estate of Kaidon Montgomery (Plaintiff) vs. Kids2, Inc. et.al. (Defendant).* Civil No. No.: 3:21-CV-166. District Court of Western Pennsylvania. Working on behalf of the Plaintiff. Plaintiff Attorney: Thomas Bosworth, Esq., Klein and Specter, P.C. (deposition).
42. *Tomassetti (Plaintiff) vs. Little Giant Ladder (Defendant).* Case No. 22-CV-2587(VB). Working on behalf of the Plaintiff. Plaintiff Attorney: Terry McCarty, Esq., Reiner, Slaughter, McCartney & Frankel LLP., Rye, NY. Terry McCartney, (3-part deposition).
43. *John Deere (Plaintiff) vs Kinze Manufacturing, Inc. and Ag Leader, Inc. (Defendants).* Case No. 4:2020cv00389. District Court of Iowa. Working on behalf of Plaintiff. Infringement and Validity of a set of 13 patents for the ExactEmerge ™ precision planting product line. U.S. Patent Numbers: 8,671,856; 8,813,663; 8,850,998; 9,480,199; 9,510,502; 9,661,799; 9,686,906; 9,699,955; 9,807,922; 9,807,924; 9.820,429; 9,861,031; 10,004,173. Nathan Mammen, Kirkland and Ellis LLP, Washington, D.C. (deposition and 2 trial appearances).
44. *Norge Holdings, LLC and Alien Technologies Corp. (Plaintiffs), vs John D. Cullinan and Lynx Precision Products Corp. (Defendant).* District Court of Southern Ohio, Western Division. Infringement and Validity of a Sports Utility Vehicle Hard Top Removal Device Patent, U.S. Patent Number US9,643,823. Testimony and declaration in support of Plaintiff's Temporary restraining order and preliminary injunction. Working on behalf of the Plaintiff. Eric Gaum, Taft, Cleveland, OH. Case No. 1:20-CV-00918-MVM. (court testimony).
45. James Rowedder v. Primal Vantage Company, Inc., and Dick's Sporting Goods. Inc. d/b/a Field & Stream. District Court of South Carolina. Working on behalf of Plaintiff. Ronnie Crosby, Parker Law Group, LLP, Hampton, S.C. Civil Action No.: 2:22-cv-2371-RMG. (deposition)

- <u>Expert Witness – *Patent Infringement, Validity & Other Patent Litigation Matters*</u>
  1. Cline Williams Wright Johnson & Oldfather, L.L.P., Lincoln, NE. (2003). *Automated Layout Technology, LLC v. Precisions Steel Systems, LLC, Donner Steel Works, Inc., and Nicholas Donner*, Working on behalf of the Defendants. U.S. Patents Numbers: 10,576,588 and 11,426,826. Case No. 4:20- cv-3127.
  2. Freeman Mathis and Gary, LLP. (2023). *Dae Sung Hi Tech Co., LTD, and First 2 Market Products, LLC v D&B Sales, Inc. et al.* Working on behalf of the Plaintiffs. U.S. Patent Number 7503696. Case No. 2:22-cv-00030-ART-BNW.
  3. Rothwell, Figg, Ernst & Manbeck, P.C., Washington, D.C. (2023). *Unverferth Manufacturing Co., Inc. (Plaintiff) vs. Par-Kan (Defendant).* Infringement of Agricultural Seed Tender with Pivoting Conveyor, U.S. Patent Numbers: 8,221,047, 8,967,940, and 9,745,123. Working on behalf of Plaintiff. Case No. TBD
  4. Saul Ewing Arnstein & Lehr LLP, Chicago, IL. (2022-present). *Pipp Mobile Storage Systems, Inc. (Plaintiff) v Innovative Growers Equipment, Inc. (Defendant).* U.S. Patent Number 10,806,099. Working on behalf of the Defendants. Case No.: 1:21-cv-2104.
  5. Rothwell, Figg, Ernst & Manbeck, P.C., Washington, D.C. (2022-2023). *Dynamic Motion Rides GMBH et al. (Plaintiffs) v. Universal City Development Partners Ltd. et al. (NBC Universal and the Disney Co.) (Defendants)*. U.S. Patent Numbers: 9,259,657; 9,536,446; and 10,283,008. Working on behalf of the Defendants. Case No. 21-cv-752-RBDLRH (M.D. Fl.).
  6. Kirkland & Ellis (2022-present). *John Deere (Plaintiff) vs Kinze Manufacturing, Inc. and Ag Leader, Inc. (Defendants).* Infringement of a set of 13 patents for the ExactEmerge ™ precision planting product line. U.S. Patent Numbers: 8,671,856; 8,813,663; 8,850,998; 9,480,199; 9,510,502; 9,661,799; 9,686,906; 9,699,955; 9,807,922; 9,807,924; 9.820,429; 9,861,031; 10,004,173. Working on behalf of Plaintiff. Case No. 4:2020cv00389.
  7. Taft Stettinius & Hollister LLP. Cleveland, OH. (2021-present). Norge Holdings, LLC and Alien Technologies Corp., *(Plaintiffs) vs John D. Cullinan and Lynx Precision Products Corp. (Defendant).* Infringement of a Sports Utility Vehicle Hard Top Removal Device Patent, U.S. Patent Number US9,643,823. Working on behalf of the Plaintiff. Case No. 1:20-CV-00918-MVM.
  8. Sterne, Kessler, Goldstein & Fox P.L.L.C., Washington, D.C. (2020-2022). *Steuben Foods, Inc. (Plaintiff) vs. Shibuua Hoppman, LLC. and HP Hood LLC (Defendants).* Infringement of *Several Aseptic Methods and Processing Machines.* U.S. Patent Numbers: 6,209,591, 6,536,188 and 6,702,985. Working on behalf of Defendant. Case No. CV-00781-WMS-JJM.

9. Harter Secrest & Emery LLP, Buffalo, NY (2020-present). ABM International, Inc (Plaintiff). vs. Juki America, Inc. et al. *Inter Partes Review* Expert in front of the Patent Trial and Appeals Board for U.S. Patent Number: 9,840,797. Working on behalf of Plaintiff. Case No. IPR2020-01371.
10. Nyemaster Goode PC, Des Moines, IA. (2020-21). *John Deere (Plaintiff) vs Kinze Manufacturing, Inc. and Ag Leader, Inc. (Defendants).* Infringement of a set of 13 patents for the ExactEmerge ™ precision planting product line. U.S. Patent Numbers: 8,671,856; 8,813,663; 8,850,998; 9,480,199; 9,510,502; 9,661,799; 9,686,906; 9,699,955; 9,807,922; 9,807,924; 9.820,429; 9,861,031; 10,004,173. Working on behalf of Plaintiff. Case No. 4:2020cv00389.
11. Harter Secrest & Emery LLP, Buffalo, NY (2020-present). ABM International, Inc (Plaintiff). vs. Juki America, Inc. et al. *Infringement* of U.S. Patent Number: 9,840,797. Working on behalf of Plaintiff. Case No. Case No. IPR2020-01371.
12. Covington and Burling, LLP, Washington, D.C. (2019-2021). *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants).* Inter Partes Review Expert in front of the Patent Trial and Appeals Board for U.S. Patent Numbers: 8,671,856; 8,813,663; 8,850,998; 9,480,199; 9,510,502; 9,661,799; 9,686,906; 9,699,955; 9,807,922; 9,807,924; 9.820,429; 9,861,031; 10,004,173. Working on behalf of the Plaintiff. Case No's. IPR2019-01044, IPR2019-01046, IPR2019-01055, IPR2019-01053, IPR2019-01052, and IPR2019-01048.
13. Sheridan Ross, PC., Denver, CO (2020-present). *Olati LLC v Hass Automation*. Infringement of a Numerical Control Algorithm for Controlling Machined Surface Finish. U.S. Patent Number: 8,136,432. Working on behalf of the Plaintiff. Case No. IPR2021-00146.
14. Haley Guiliano, LLP, San Jose, CA (2019-present). *Cherokee Eagle LLC (Plaintiff) v Skyzone, LLC, et al. (Defendants)*. Infringement of an indoor trampoline arena. U.S. Patent Number: 8,764,575. Working on behalf of the Plaintiff. Case No. 6:18-cv-355-Orl-40TBS.
15. Taft Stettinius & Hollister LLP. Cleveland, OH. (2019-2020). *H.W.J. Designs for Agribusiness, Inc., and Samuel Strapping Systems, Inc. (Plaintiff) v. Rethceif Enterprises, LLC, Brown Company, Inc., D/B/A International Fiber Packaging (Defendant)*. Infringement of a Cotton Bale Wrapper and Sampler, U.S. Patent Numbers: 9,463,885 and 8,336,404. Working on behalf of the Defendant. Case No.1:17-CV-0272-AWI-SKO.
16. Rothwell, Figg, Ernst & Manbeck, P.C., Washington, D.C. (2019-2022). *Unverferth Manufacturing Co., Inc. (Plaintiff) vs. Meridian Manufacturing Corp. (Defendant)*. Infringement of *Agricultural Seed Carrier with Pivoting Conveyor*, U.S. Patent Numbers: 8,221,047, 8,967,940, and 9,745,123. Working on behalf of the Plaintiff. Case No. 5:19-cv-4005.
17. Covington and Burling, LLP, Washington, D.C. (2018-22). *John Deere (Plaintiff) vs AGCO and Precision Planting (Defendants).* Infringement of a set of 13 patents for the ExactEmerge ™ precision planting product line. U.S. Patent Numbers: 8,671,856; 8,813,663; 8,850,998; 9,480,199; 9,510,502; 9,661,799; 9,686,906; 9,699,955; 9,807,922; 9,807,924; 9.820,429; 9,861,031; 10,004,173. Working on behalf of Plaintiff. Case No. C.A. No. 18-872 (CFC) (consolidated).
18. Rothwell, Figg, Ernst & Manbeck, P.C., Washington, D.C. (2018-19). *Unverferth Manufacturing Co., Inc. (Plaintiff) vs. Norwood. (Defendant)*. Infringement of Agricultural Seed Tender with Pivoting Conveyor, U.S. Patent Numbers: 8,221,047, 8,967,940, and 9,745,123. Working on behalf of Plaintiff. Case No. 3:18-cv-00053.
19. David Gerasimow, Esq., Blackbird Technologies, Boston, MA. (2017-18). *Blackbird Technologies, Inc. (Plaintiff) vs. Lenovo Corporation (Defendant)*. Infringement of *Multipurpose Computer Display System*, U.S. Patent No. 7,129,931. Working on behalf of Plaintiff. C.A. No. 16-cv-140-RGA.
20. Rothwell, Figg, Ernst & Manbeck, P.C., Washington, D.C. (2016-18). *Unverferth Manufacturing Co., Inc. (Plaintiff) vs. J&M Manufacturing Co., Inc. (Defendant)*. Infringement of *Agricultural Seed Carrier with Pivoting Conveyor*, U.S. Patent No. 8,221,047. Working on behalf of Plaintiff. Civil Action No. 3:16-cv-02282-JZ
21. Daneker, McIntire, Schumm, Prince, Manning & Widmann, P.C., Baltimore, MD. (2011). Testing to demonstrate infringement of Hard Cap™ patent by a foreign manufacturer. U.S. Patent No. 908,996.
22. Brooke Schumm, Esq., Baltimore, MD. (2010). Prototyping and reduction to practice of U.S. Patent No. 8,092,370.
23. Laura Simon, Esq., Dalton and Associates, Wilmington, DE. (2008) Prototyping and reduction to practice of U.S. Patent No. 6,957,510.

- <u>Expert Witness – *Product Liability Litigation and Investigations, and Personal Injury Lawsuits*</u>

1. Ronnie Crosby, Esq., Parker Law Group, LLP, Hampton, SC. In-flight failure of the flight control mechanism on a two-seat monoplane. (2023).
2. Brian Corcoran, Esq., Fellerman & Ciarimboli Law PC, Kingston, PA. Injuries resulting from use of a forklift backup impact. (2023).
3. Ronnie Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Runover injury from a linear-move irrigation system. (2023).
4. Phillip Mazzotti, Esq., Martin, Harding & Mazzotti, LLP, Albany, NY. Burning fuel emission from a tabletop pit, and associated burns. (2023)
5. Michael Edwards, Esq., Freeman Mathis & Gary, LLP, Las Vegas, NV. Alleged misuse of a water kettle available in a casino hotel room. (2023).
6. Brian Corcoran, Esq., Fellerman & Ciarimboli Law PC, Kingston, PA. Injuries resulting from use of a water jet ski. (2023).
7. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Leg amputation from an intake conveyor for a saw mill board trimming operation. (2023).
8. Don Corson, Esq., Corson and Johnson Law Firm, Eugene, OR. Failure of a gooseneck trailer coupling. (2023).
9. Alberto Guerrero, Esq. Mask & Guerrero, Trial Attorneys. McAllen, TX. Evaluation of a fall involving a Little Giant Multipurpose Leveler Ladder. (2023).
10. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Finger amputation from a collapsible basketball hoop and backboard structure. (2023).
11. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a failed garage door and lift, and resulting back injury. (2023).
12. Andrew Valentin, Esq., Schuster Law and Associates, Media, PA. ATV front end installation and failure. (2023).
13. Brian Corcoran, Esq., Fellerman & Ciarimboli Law PC, Kingston, PA. Zero turn mower misuse and rollover. (2023).
14. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Finger amputation from an unguarded transport conveyor. (2023).
15. Brian Anderson, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a bicycle brake system failure and resulting injury from a downhill crash. (2023).
16. Michael Conley, Esq., Kenney & Conley, P.C., Braintree, Massachusetts. Tip over and injury from a wheeled dumpster. (2023).
17. Justine Bernstein, Esq., Schuster Law and Associates, Media, PA. Traffic cone distribution truck body structural failure and injury. (2023).
18. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Finger amputation caused by a coating machine and roller nip. (2023).
19. Will Owen, Esq., Musselwhite, Musselwhite, Branch & Grantham, P.A., Lumberton, NC. Failure of a hydraulic powered fence post driver and resulting injuries. (2023).
20. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Finger amputation of caused by a plastic shredder and air conveyor. (2023).
21. Greg Spizer, Esq. VSCP Law, Philadelphia, PA. Infant death in an inclined infant sleeping device. (2022-present).
22. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Fall and injury from a failed scaffolding walkway. (2022-present).
23. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, SC. Hand and finger crushing in a baling machine used for plastic bale forming and wrapping. (2022-present).
24. Ronnie Crosby, Esq., Parker Law Group, LLP, Hampton, S.C. Fall from a climbing-type tree stand for hunting. (2023).
25. Terry McCarty, Reiner, Slaughter, McCartney, Frankel LLP., Rye, NY. Failure of a coffee percolator handle and resulting scalding injury. (2022-23).
26. Michael Trunk, Esq., Kline and Specter, PC. Philadelphia, PA. Class action suit against an infant inclined sleeper manufacturer (Kids 2, Inc.) related to multiple SIDS deaths – evaluation of the engineering design process used to develop the at-issue Kids 2, Inc. product. (2022-23).
27. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Hand crushing during the assembly of a pumping station using an overhead crane. (2022-present).

28. Ronnie Crosby, Esq., Parker Law Group, LLP, Hampton, S.C. Crushing incident and fatality from a failed robotic palletizer safety shutdown system. (2022-present).
29. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Respiratory disease from long term use of a failed PPE sandblasting suit and breather. (2022-present).
30. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Fire and burns from an infant Pack and Play. (2022-present).
31. Mauro Ruiz, Esq., Ruiz Law Firm P.L.L.C., McAllen, TX. Failure of motorized hurricane exterior shutters and resulting death during a building fire. (2002-present)
32. Chad Shannon, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a bicycle brake system failure and resulting traffic injury. (2022-present).
33. Austin Crosby, Esq., Parker Law Group, LLP, Hampton, S.C. Entanglement death in a bulk de-baling machine used for plastic bottle recycling. (2022-present).
34. Alberto Guerrero, Esq. Mask & Guerrero, Trial Attorneys. McAllen, TX. Examination and analysis of effects of a water/soap mixture on a non-slip tile floor at a La Quinta hotel. (2022-present).
35. Ronnie Crosby, Esq., Parker Law Group, LLP, Hampton, S.C. Entanglement amputation in a defective screw conveyor caused by a failed lock out/tag out safety system and lack of engineering safety controls. (2022-present).
36. Kevin O'Brien, Esq., Sampone O'Brien Dilsheimer Law, Cheltenham, PA. Class action suit against an infant inclined sleeper manufacturer (Kids 2, Inc.) related to multiple SIDS deaths – evaluation of the engineering design process used to develop the at-issue Kids product. (2022-present).
37. Carl Schiffman, Esq., Schiffman Firm, Pittsburgh, PA. Structural analysis of the failure of two small step ladders. (2022-present).
38. Matt Dillon, Esq., Martin, Harding & Mazzotti, LLP, Albany, NY. Injury from a right-angle grinder switch failure. (2022-present)
39. Ryan H Fisher, Esq., Lowe Scott Fisher Co LPA, Cleveland, OH. Slip out failure of an articulating ladder configured as an extension ladder. (2022).
40. Chad Shannon, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a portable ladder and scaffold structural failure and injury. (2022).
41. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Injury resulting from a powered multi-pallet pallet jack. (2022-present).
42. Miguel Dilley, Esq. Dilley Law Firm, San Antonio, TX. Child injury from a Walmart clothing rack collapse. (2022).
43. Robert Reardon, Esq. The Reardon Law Firm, P.C., New London, CT. Arm injury from a wire rope winding machine. (2021-present).
44. Thomas Mortati, Esq., Martin, Harding & Mazzotti, LLP, Albany, NY. Hand amputation by a commercial bag label printing machine. (2021-present)
45. Douglas Dilley, Esq. Dilley Law Firm, San Antonio, TX. Analysis of the frictional attributes, warnings, and injury associated with a wet tile floor fall at a McDonalds restaurant. (2021-present).
46. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Fatality caused by a fall from a concrete mixer truck. (2021-present).
47. Ian M. Bauer, Esq., Hagens, Berman, Sobol, Shapiro LLP, Seattle WA. Analysis of a rope climbing device failure and manufacturing and design defect. (2021-2022).
48. Brian Cox, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a crossbow structural failure and injury. (2021-present).
49. Thomas Mortati, Esq., Martin, Harding & Mazzotti, LLP, Albany, NY. Amputation by a Cabalas commercial meat grinder. (2021-present)
50. Ian Watt, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a leg amputation in a commercial saw mill. (2021-2022).
51. Terry McCarty, Esq., Reiner, Slaughter, McCartney & Frankel LLP., Rye, NY. Engineering analysis and testing of an articulated ladder slipout failure. (2021-present)
52. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Fatality from a stairs chair lift and battery charging system (2021-2022).
53. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Amputation caused by a concrete pump misstart. (2020-2022).
54. Raymond Gill, Esq., Gill and Chamas, LLC, Woodbridge, NJ. Portable charcoal grill structural failure and fatal fire. (2020-present).

55. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Rotating cutter shroud failure on a wood chipper. (2020-present).
56. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Finger amputations caused by a stationary Porter Cable (Black and Decker) router. (2020).
57. Jason Schiffman, Esq., Schiffman Firm, Pittsburgh, PA. Kickback of a hand held Black and Decker circular saw. (2020-present).
58. Aaron Parker, Esq., Law Offices of Peter G. Angelos, Baltimore, MD. Finger loss injury from a Black and Decker table saw. (2020-present).
59. Thomas Mortati, Esq., Martin, Harding & Mazzotti, LLP, Plattsburgh, NY. Amputation from an unguarded mechanical drive train on a printing press. (2021-present)
60. John E. Osborne, Esq. Goldberg & Osborne LLP. Tucson, AZ. Examination and testing of an OTR tire change machine related to an operator fatality. (2019-2022).
61. Alberto Guerrero, Esq. Mask & Guerrero, Trial Attorneys. McAllen, TX. Assessment of ADA compliance of an outside ramp on South Padre Island, TX. (2019-2021).
62. Douglas B. Cannon, Esq., Fabian & Clenndenin, P.C., Salt Lake City, UT. Analysis and testing of an articulated ladder, configured as an extension ladder, slip out injury. (2019-present).
63. John E. Osborne, Esq. Goldberg & Osborne LLP. Tucson, AZ. Refuse truck incident involving catastrophic injuries from flying debris. (2019-2022).
64. Wayne Marvel, Esq. Maron Marvel Bradley Anderson & Tardy LLC. Wilmington, DE. Examination and analysis of a fall injury with a Dewalt battery heated jacket. (2018-2022)
65. Alberto Guerrero, Esq. Mask & Guerrero, Trial Attorneys. Hidalgo, TX. Examination and analysis of effects of water on a non-slip tile floor at a Lava Wash Laundromat. (2019-20).
66. Scott E. Schermerhorn, Esq. Law offices of Scott E. Schermerhorn. Scranton, PA. Analysis of an automotive lift collapse and crushing event. (2018-2020).
67. Miguel Dilley, Esq. Dilley Law Firm, San Antonio, TX. Analysis of a scaffold failure and OSHA-related jobsite violations. (2018).
68. James Thompson, Esq. Edelman and Thompson, LLC. Kansas City, MO. Structural failure of a fiberglass industrial stepladder. (2018-present).
69. Alberto Guerrero, Esq. Mask & Guerrero. McAllen, TX. Kinematics and kinetics of a Volvo tractor-trailer and car collision. (2018).
70. Jody Mask, Esq. Mask & Guerrero, Trial Attorneys. San Antonio, TX. Examination and design analysis of a failed fall arrester and fall arrest system. (2018).
71. Alberto Guerrero, Esq. Mask & Guerrero, Trial Attorneys. McAllen, TX. Analysis of a fiberglass crossbow structural failure and injury. (2018).
72. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of the failure of a polymer spray applicator for coating fabrics. (2017).
73. Scott Kagan & Terry McCarty, Reiner, Slaughter, McCartney & Frankel LLP. Rye, NY. Evaluation and testing of a molded elastomeric foot on a multipurpose aluminum ladder. (2017-present).
74. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Railing failure and fall from a 5^{th} story apartment porch. (2017-present)
75. Alberto Guerrero, Esq. Cowen, Mask and Blanchard Attorneys at Law. McAllen, TX. Analysis of a low speed impact between two tractor trailers. (2017).
76. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a natural gas repair site and associated signage and traffic accident. (2017).
77. Linsey Scarcello, Esq., Langdon and Emison, LLC, Lexington, MO. Analysis of an articulating ladder molded foot design. (2017-18)
78. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a natural gas repair site and associated signage and traffic accident. (2017).
79. Pete Friday, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a welding torch and failure and clothing fire. (2017).
80. Anthony Pinnie, Esq. Schuster Law and Associates, Media, PA. Failure of a polymer nut on a Pfister bathroom sink fixture. (2017)
81. Jody Mask, Esq., and Alberto Guerrero, Esq. Cowen, Mask and Blanchard Attorneys at Law. Donna, TX. Walkway trip and fall, and assessment of the American Disabilities Act design requirements. (2017)
82. Pete Friday, Esq., and Josh Licata, Esq., Friday and Cox, LLC. Pittsburgh, PA. Analysis of a large elastomeric hose failure after post extrusion pressure testing. (2017).

83. Jody Mask, Esq., and Alberto Guerrero, Esq. Cowen, Mask and Blanchard Attorneys at Law. McAllen, TX. Modeling of the kinetics of an impact between a John Deere backhoe and a pickup truck. (2017)
84. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of the failure of a harness during the fall of worker cutting of a tree. (2016).
85. Chris Apessos Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a rear end collision involving a bumper hitch recreational trailer. (2016).
86. Alberto Guerrero, Esq. Cowen, Mask and Blanchard Attorneys at Law. McAllen, TX. Forensic evaluation of a fall involving a mobile ladder. (2016-present)
87. Greg Nicosia, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of an incident involving a Caterpillar Excavator. (2016).
88. Joshua Licata, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of an electrocution involving a truck mounted aerial lift. (2016).
89. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Extremity laceration and equipment evaluation of a highschool wood shop tablesaw. (2015-17).
90. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Evaluation of a pallet jack foot crushing incident. (2015-present).
91. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a fall into a press for manufacturing tubing. (2015-17).
92. Justin Bernstein, Esq. Schuster Law and Associates, Media, PA. Extremity loss evaluation from an automated chopsaw. (2015).
93. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a fall from a scissors lift (2015-present).
94. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a motorcycle ignition switch failure. (2015-present).
95. Amy Eddy, Esq. The Law office of Amy Eddy, PLLC. Kalispell, MT. Examination of a fiberglass extension ladder failure. (2015-16).
96. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Determining the impact characteristics of a rear truck bumper during a rear end collision. (2015-16).
97. Kevin Burger, Esq. Friday and Cox, LLC. Pittsburgh, PA. Analysis and testing of failed concrete reinforcement (rebar). (2015-2022).
98. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Determining the permeability characteristics of a crib bumper. (2015).
99. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a hunting stand structural failure. (2015-present).
100. Scott Kauff, Esq. Law Offices of John K. Dema, PC., St. Croix, Virgin Islands Analysis of a failed aluminum step ladder assembly. (2015-present).
101. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a failed clip for bicycle clip-in shoes. (2015-19).
102. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Examination of an ATV accident involving an unmarked electric pole guy wire. (2014-present)
103. Anthony Pinnie, Esq. Schuster Law and Associates, Media, PA. Examination of an electric cable transfer system at the Philadelphia Water Department's Receiving Station. (2014-present).
104. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of an amputated arm accident by a horizontal boring machine. (2014-present).
105. Justin Bernstein, Esq. Pinnie Law Offices., Media, PA. Analysis of a smoke tunnel door latch system failure on a paper manufacturing system. (2014-2015).
106. James Navagh, Esq. The Law Office of John Wallace. Buffalo, NY Analysis of failed fiberglass ladder siderail. (2014 – present).
107. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a failed weld on a wood chipper jack. (2014-present)
108. Allan Freeman, Esq. Schultz Law LLC. Conshohocken, PA. Evaluation of a failed fiberglass step ladder. (2014-present).
109. David Cutt, Esq. Eisenberg, Gilchrist, and Cutt. Salt Lake City, UT. Analysis and testing of a failed aluminum step ladder. (2014 – present).
110. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a crushing head impact on an enclosed water slide stairs. (2014-present).

111. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of an electrocution from overhead power lines. (2014-present).
112. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of a powered rotating entrance door at a casino. (2013).
113. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Evaluation of the electrocution of a tree trimmer. (2013-present).
114. Peter Friday, Esq. Friday and Cox, LLC. Pittsburgh, PA. Examination of a leg crushing accident involving a natural gas well beam pump. (2013-2015).
115. Bobby Kenny, Kenny Brothers, Inc. Bridgeville, DE. Analysis of a fractured GM diesel engine crank shaft. (2012).
116. Craig Hilborn, Esq., Hilborn & Hilborn, Birmingham, MI. Analysis of a step failure on a bucket truck fiberglass bucket. (2012-13)
117. Brantly White, Esq. Sico, White, Hoelscher, Braugh. Corpus Christi, TX. Analysis of an aluminum extension ladder failure. (2012-14).
118. David L. Jones, Esq., Jones Law Firm, P.L.L.C., Corpus Christi, TX. Analysis of an apartment heater temperature controller failure. (2011-12).
119. Gregory Hopper Esq., Salsbury, Clements, Bekman, Marder & Adkins, LLC. Analysis of a ladder failure. Baltimore, MD. (2011-12).
120. David L. Jones, Esq., Jones Law Firm, P.L.L.C., Corpus Christi, TX. Analysis of an extrusion machine design and accident. (2011-13).
121. David Kramer, Esq., Hilborn & Hilborn, Birmingham, MI. Analysis of failed fiberglass ladder siderail. (2011-14).
122. Kristen Sinisi, Esq., Angino and Associates, Harrisburg, PA. Analysis and testing of a failed aluminum stepladder. (2011-13)
123. Brett Farney, Esq., Farney Law Office, San Antonio, TX. Analysis of a failed aluminum step ladder side rail and first step. (2011-2012).
124. Joel Rosen, Esq. Cohen, Placitella & Roth, P.C., Philadelphia, PA. Analysis of an oxygen cylinder failure and injury. (2011-12).
125. Cameron Davis, Esq., Hoversten, Johnson, Beckmann & Hovey, Austin, MN. Failure analysis of a failed aluminum extension ladder. (2011-13).
126. Douglas B. Cannon, Esq., Fabian & Clenndenin, P.C., Salt Lake City, UT. Failure analysis of the structural failure of an articulating ladder. (2011-13).
127. John O'Connell, Esq., O'Connell and Associates, PC. Denver, CO. Analysis and testing of a failed aluminum telescoping extension ladder. (2010-12).
128. David J. DeToffol, Esq. DeToffol & Associates Attorneys at Law. New York, NY. Failure analysis of the locking pin on a telescoping extension ladder. (2010-12).
129. David L. Jones, Esq., Watts, Guerra, and Craft LLP, Corpus Christi, TX. Stress analysis and testing of a Grade A, class 2 shackle failure and injury. (2010-12).
130. David L. Jones, Esq., Watts, Guerra, and Craft LLP, Corpus Christi, TX. Analysis and testing of a Schedule 160 high pressure pipe fitting failure and fatality. (2010-12).
131. David L. Jones, Esq., Watts, Guerra, and Craft LLP, Corpus Christi, TX. Georgia buggy accident and operator injury investigation. (2010-present).
132. Thomas J. Gilbride, Esq. O'Malley & Langan, P.C., Scranton, PA. Failure analysis of an aluminum scaffold jack. (2010).
133. Kiersta D. Perlee, Esq., The Arnold Law Firm, Sacramento, CA. Structural analysis of a failed fiberglass channel. (2010).
134. Tom Power, Esq. Power, Rogers & Smith, P.C., Chicago, IL. Examination of a failed rubber foot. (2010-present).
135. Peter Friday, Esq. Friday, Porta, Cox, and Ward, LLC. Pittsburgh, PA. Evaluation of the swimming pool electrocution. (2010).
136. Jeff Clark, Esq., Schmittinger & Rodriguez, Dover, DE. Analysis and testing of a pultruded fiberglass structural failure. (2010-12).
137. Eugene McGurk, Esq., Raynes McCarty, Philadelphia, PA. Analysis of the structural failure of a carbon fiber bicycle frame. (2010-2012).
138. Christina T. Novajosky, Esq. O'Malley & Langan, P.C., Scranton, PA. Analysis of a foot pad failure and overall stability of an aluminum step ladder. (2010).

139. Tim Lengkeek, Esq., Young, Conaway, Stargatt, & Taylor, LLP, Wilmington, DE. Analysis of an accident involving a conveying system. (2009).
140. Junie Sinson, Esq, Sinson & Sinson, LTD, Chicago, IL. Analysis of a ladder side rail structural failure. (2009-present).
141. Devon Bruce, Esq., Power, Rogers & Smith, P.C., Chicago, IL. Examination of a fiberglass side rail failure. (2009).
142. A.J. Sackett & Sons, Inc., Baltimore, MD. Review of a load out conveyor and blending system design and accident. (2009).
143. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Analysis of the electro-hydraulic system design and failure for a trailer boom lift accident. (2009). – just papers
144. Lauren Hudecki, Esq., Young, Conaway, Stargatt, & Taylor, LLP, Wilmington, DE. Analysis of an accident involving a hydraulically driven screening machine (2009).
145. Wyatt Stevens, Esq., Roberts & Stevens, P.A., Asheville, N.C. Testing and analysis of a high performance carbon fiber water ski failure. (2009).
146. David L. Jones, Esq., Watts, Guerra, and Craft LLP, Corpus Christi, TX. Analysis of an aluminum step ladder failure. (2009).
147. Peter Friday, Friday, Porta, Cox, and Ward, LLC. Pittsburgh, PA. Analysis and testing of a horizontal mixing mill safety shutdown system. (2009).
148. John Roberts, Esq., Ball, Hulbert and Roberts. Analysis of a fiberglass step ladder failure. Pasadena, CA (2008).
149. The Dalton Law Firm, Wilmington, DE. Structural analysis and property testing of aluminum step ladder (2007-2008).
150. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Analysis and testing of a defective cast aluminum motorcycle wheel. (2007-08).
151. O'Malley & Langan, P.C., Scranton, PA. Failure analysis of a portable steel ladder failure and accident. (2006)
152. Craig D. Brown, Esq., Foote, Meyers, Mielke & Flowers, Geneva, Illinois. Analysis of a spreader bar failure on a step ladder. (2006-07).
153. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Analysis and testing of a fiber reinforced composite cut-off wheel for abrasive metal cutting (2006-2008).
154. The Walker Law Group, Clearwater, FL., Analysis of fiberglass step ladder failure (2006-present).
155. Richard South, Esq., Wright and Greenhill, P.C., Austin TX., Analysis and testing of an articulating ladder failure. (2006-09).
156. Joel Rosen, Esq. Cohen, Placitella & Roth, P.C., Philadelphia, PA. Analysis of a snap blade knife failure and accident. (2006-09).
157. Welebir & McCune, Redlands, California. Failure analysis of a fiberglass step ladder. (2006-08).
158. Mary Buonanno, Esq., Attorney-at-Law, Takoma Park, MD. Failure analysis of a composite extension ladder siderail. (2006-08).
159. Danny Henderson, Esq., Peters, Murdaugh, Parker, Eltzroth & Detrick Law Offices, Hampton, SC. Failure analysis of an aluminum step stool. (2006-09).
160. Cohen, Placitella & Roth, P.C., Philadelphia, PA. Preliminary analysis of a window failure. (2006-07).
161. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Evaluation of the safety shutdown system on a concrete power trowel (2006).
162. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Structural analysis and testing of an extension ladder. (2006).
163. Steven Stambaugh, Esq., Stambaugh Law, York, PA. Analysis of a forklift brake failure. (2006).
164. Edgar Snyder and Associates, Pittsburgh, PA. Analysis and ASTM testing of the structural failure of a polyethylene molded chair. (2006).
165. Edgar Snyder and Associates, Pittsburgh, PA. Analysis of the structural failure of a composite bike fork. (2006).
166. O'Malley & Langan, P.C., Scranton, PA. Failure analysis of a step stool accident. (2006)
167. Ronald Owen, Attorney at Law, Jacksonville, FL. Failure analysis of a fiberglass extension ladder. (2004-present).
168. O'Malley & Langan, P.C., Scranton, PA. Biomechanics of the impact of a clevis pin on the human skull and neck fitted with a hardhat. (2004-present).

169. Todd S. Miller and Associates, Allentown, PA. Evaluation of a brake failure on a hydrostatic drive, self-propelled asphalt paver. (2004-05).
170. Ferrara, Rossetti & DeVoto, P.A., Cherry Hill, NJ. Preliminary failure analysis of the power train on a shaft-drive motorcycle. (2004).
171. O'Malley & Langan, P.C., Scranton, PA. Analysis of a motorcycle steering column failure and accident. (2004-present)
172. Peter Friday, Esq., Woomer and Friday, Attorneys at Law, LLP, Pittsburg, PA. Analysis and testing of a horizontal mixing mill accident. (2003-05).
173. Todd O'Malley, Esq., O'Malley & Langan, P.C., Scranton, PA. Analysis of an automotive jackstand failure. (2003-07).
174. Leavis and Rests, P.C., Boston, MA. Analysis and experimental evaluation of a defective childs toy. (2003-07).
175. Crews and Bodiford, P.A., Orlando, FL. Failure analysis and testing of a composite sandwich structure water ski. (2003-06).
176. Leavis and Rests, P.C., Boston, MA. Failure analysis of an aluminum extension ladder siderail. (2003-06).
177. Gibson, Valenti & Ashley, P.A., Lake Wales, FL. Rivet pullout analysis of a fiber reinforced structure. (2003-05).
178. Smith, Phillips, Mitchell and Scott, Hernando, MS. Failure analysis of an aluminum open channel. (2003-05).
179. Robert M. N. Palmer, P.C., Springfield, MS. Failure analysis of an aluminum step ladder. (2003-05).
180. Frankel, Cunningham, Stambaugh & Associates, York, PA. Failure of an aluminum extension ladder. (2003-05).
181. Hardin, Kundla, McKeon, Poletto & Polifroni, Springfield, NJ. Fiberglass side rail structural analysis and testing for a failed Werner step ladder. (2003-05).
182. Kessler, Cohen, and Roth, Inc., Philadelphia, PA. Structural analysis and testing of an aluminum folding walker. (2003).
183. Hourigan, Kluger, and Quinn, Kingston, PA. Failure analysis of an aluminum step ladder. (2002-03).
184. The Krasnow Law Firm, Roanoke, VA. Failure analysis of a fiber-reinforced step ladder. (2002-03).
185. Smith, Stephens, Reed & Phillips, Inc., Pittsburgh, PA. Evaluation/testing of the safety shutdown system on a horizontal mixing mill. (2002).
186. Litvin, Blumberg, Matusow, and Young, Philadelphia, PA. Evaluation/testing of the crushing potential of a vehicle power seat with position memory. (2002-03).
187. Venable, Baetjer, Howard & Civiletti, LLP, Washington, D.C. Failure analysis and testing of an exercise device. (2002).
188. Kessler, Cohen, and Roth, Inc., Philadelphia, PA. Failure analysis of a vending machine fan motor. (2002).
189. Scanlon and Co., LLC, Akron, OH. Failure analysis of an aluminum step ladder. (2002).
190. Universal Underwriters Group, Overland Park, KS. Product liability design evaluation. (2002).
191. Kessler, Cohen, and Roth, Inc., Philadelphia, PA. Assessment of the design, and testing of a concrete chop saw. (2001).
192. Structural Mechanics Associates, Inc., Philadelphia, PA. Various stress analysis projects for extruded aluminum and fiber-reinforced structures. (1999-2019).
193. National Forensic Engineers, Inc., Pittsburgh, PA. Various failure analysis of step ladders accident cases. (1999-2005).

- <u>Professional Engineering Mechanical Design Services - *Industry and Government*</u>
  1. Mid-Atlantic Organic Resource Recovery Company, Ridgley, MD. Design of a large circular rotating composting vessel and drive for composting poultry renderings. (2023).
  2. Fifer Orchards, LLC, Wyoming, DE. Design of a high capacity durable sweep for sweet corn distribution to the packing line workers. (2023).
  3. Fennimore Construction, Inc., Clayton, DE. Floor joist sizing and footer requirements for a porch addition to an existing home. (2023).
  4. L&L Farms, Inc., Townsend, DE. Structural damage caused by the ridged mounting of a screw-type conveyor to the top of a grain bin. (2023).
  5. Siemens Healthcare Diagnostics, Glasgow, DE. Measurement of hand squeeze force and load to failure for a new bottle cap design with reduced geometric features to lower stress concentrations and increase cap strength. (2022).

6. Siemens Healthcare Diagnostics, Glasgow, DE. Design validation and testing of a new bottle cap closure for medical grade bleach compatibility. (2021-22).
7. Fifer Orchards, LLC, Wyoming, DE. Design and installation of a sweet corn truck unloading system for bulk fresh market produce. (2021).
8. Siemens Healthcare Diagnostics, Glasgow, DE. Testing to determine the causes of leaks in injection molded cuvettes. (2020).
9. EZ Venture, LLC, Harrington, DE. Design of an ethanol-based extraction process and facility for the processing of CBD hemp oil. (2019-21).
10. Fennimore Construction, Clayton, DE. Beam sizing for a home renovation. (2019).
11. Siemens Healthcare Diagnostics, Glasgow, DE. Testing to determine the degradation of polyethylene bottle caps when saturated with chloride bleach. (2019-present).
12. Duffield Associates, Wilmington, DE. Renovation plan for the New Castle County (DE) wastewater treatment facility (2019-present).
13. Siemens Healthcare Diagnostics, Glasgow, DE. Redesign of a click-lock cap for medical instrument reagents. (2019-present).
14. Siemens Healthcare Diagnostics, Glasgow, DE. Bottle sorting mechanism to prevent mechanical damage and bottle leakage. (2019-present).
15. Siemens Healthcare Diagnostics, Glasgow, DE. Load and leak testing of analytical instrument cuvettes for human fluid and reagent transport. (2018).
16. Fennimore Construction, Clayton, DE. Structural analysis of several balconies at the Bayview Development. (2018-2019).
17. Siemens Healthcare Diagnostics. Glasgow, DE. Measurement of insertion force of an injection molded insert into a regent bottle. (2017).
18. The Dupont Co., Wilmington Experimental Station, Wilmington, DE. Development of an automated XY table for rapid carbon fiber fabric formation for near net shape structural automotive components. (2016-17).
19. The Town of Middletown, Delaware. Middletown, DE. Development of a bidding and selection process for the remediation of the town-owned agricultural fields. (2014, 2016, 2018)
20. Siemens Healthcare Diagnostics. Glasgow, DE. Fatigue analysis, and mechanical and chemical testing of injection molding tooling. (2016-17).
21. Siemens Healthcare Diagnostics. Glasgow, DE. Automated torqueing of bottle lids for analytical instrument reagents. (2016-17).
22. The Town of Middletown, Delaware. Middletown, DE. Development of 150 acre sports complex utilizing treated municipal wastewater for irrigation. (2015-2017)
23. Mid Atlantic Industrial Belting, Newark, DE. Analysis of a flat belt failure. (2015).
24. ATK (Alliant Techsystems, formerly Thiokol), Elkton, MD. Analysis of a fiberglass structural failure and recommendations for an improved safety inspection procedure. (2014).
25. Dr. Peter Popper, Wilmington, DE. Modeling the needle tip spatial location during tumor sample extraction. (2013)
26. The Town of Middletown, Delaware. Middletown, DE. Calculation of field loading rates resulting from Copper Sulfate algae treatment in the wastewater lagoons. (2013)
27. Kraft Foods, Dover, DE. Design of and engineering drawing for a servo motor mount. (2013)
28. New Castle County, DE. Odessa, DE. Calculation of the assimilation rates for nutrients and heavy metals for as-needed spray irrigation with treated wastewater for the Odessa area fields. (2012)
29. The Town of Middletown, Delaware. Middletown, DE. Calculation assimilation rates for nutrients and heavy metals for as-needed spray irrigation with treated wastewater for the Burger farm. (2012)
30. Siemens Healthcare Diagnostics. Glasgow, DE. Elastic property measurement of a multi-laminant polymer film for medical applications. (2012).
31. The Town of Middletown, Delaware. Middletown, DE. Preparation of an amended permit application to expand spray-on-demand in the Middletown region. (2012)
32. Tornier, Inc. Edina, MN. Consolidation characteristics of several biomedical laminates. (2011-12).
33. The Town of Middletown, Delaware. Middletown, DE. Development and supervision of a bid process for the remediation of the dedicated spray irrigation fields used for wastewater disposal. (2011-12)
34. Siemens Healthcare Diagnostics, Glasgow, DE. Analysis of an HDPE injection molded component failure. (2011).
35. Tornier, Inc. Edina, MN. Development of a manufacturing process to consolidate and compress biomedical fabrics. (2010-2011).

36. Tornier, Inc. Edina, MN. Development of a machine vision system to quantify porosity of biomedical fabrics. (2010-2011).
37. University of Delaware, College of Engineering. Newark, DE. Load rating computation, engineering drawings and load rating label recommendations for two lift structures in the College of Engineering Machine Shop. Newark, DE (2010).
38. The Town of Odessa, Delaware. Odessa, DE. Calculation assimilation rates for nutrients and heavy metals for as-needed spray irrigation with treated wastewater. (2010)
39. Kraft Foods Inc., Dover, DE. Fastener strength requirements for an overhead crane system. (2009).
40. Consumer Union, Yonkers, NY. Evaluation of vibrating exercise machines. (2006-07).
41. Cirrus Engineering, Delaware Technology Park, Newark, DE. Measurement of cutting force dynamics for several PTFE coated microtome histologist blades. (2006-2011).
42. Institute for Energy Conversion, Newark, DE. Design and implementation of a self-tuning controller for a multi-chemical batch reactor with web handling for thin film photovoltaic manufacturing. (2003-2005).
43. Hard Hat, LCC, Baltimore, MD. Design and computer-aided-drafting of a hand-struck tool product line for overseas production. (2003).
44. George Whitmyre, Newark DE. Design of and engineering drawings for a welded steel bracket w/ compound angles. (2003).
45. Baltimore Tool Works, Inc., Baltimore, MD. Programmable Logic Controller (PLC) programming. (2002).
46. Cirrus Engineering, Inc., Wilmington, DE. Characterization of edge geometry for coated microtone knives; Estimation of cutting energy for apparel fabric and the design and automation of fabric cutting equipment. (2002-03).
47. Monsanto Co., Inc., Galena, MD. Design/Development of a pneumatic conveying system for hybrid seed. (2001-02).
48. Monsanto Co., Inc., Galena, MD. Calculation of the load capacity of a storage loft. (1999).

OUTREACH

Peer-Reviewed Extension Publications

1. Kee, W.E., J.L. Glancey, and T.L. Wootten. 2004. Successful lima bean production in Delaware: A management profile. Extension Bulletin VF-6. University of Delaware, Newark, DE.
2. Kee, W.E, K. Everts, J.L. Glancey, and T.L. Wootten. 2004. Pea production in Delaware. Extension Bulletin VF-4. University of Delaware, Newark, DE.

Glancey, J.L. 2001. Equipment for effective poultry litter management. Delaware Nutrient Management Notes. 2 (1): 1-3.

Non-Refereed Extension Publications & Reports

1. Stoops, A. and J. Glancey. 2010. Drip irrigation basics. Handout for the 2010 Twilight New Castle Growers Meeting, Newark, DE.
2. Glancey, J. 2008. Facility housing considerations for Delaware dairy farms. Proceedings of the 2008 Delmarva Dairy Day, Harrington, DE
3. Glancey, J. 2007. Mechanical sidedressing: Is there an opportunity with some horticultural crops? Proceedings of the 2007 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
4. Glancey, J. 2007. Adjustment and operation of conditioning equipment for increased drying rates and decreased dry matter losses. Proceedings of the Southern and Central Maryland Hay and Pasture Conference, Waldorf, MD.
5. Glancey, J. 2006. Mechanical harvest characteristics of several small greens. 2006. Proceedings of the 2006 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
6. Glancey, J. 2005. Performance and safety concerns with the new bandsaw-type spinach harvester. 2005. Proceedings of the 2005 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
7. Glancey, J. 2000. Flow rate requirements for center pivot irrigation systems. 2000.
8. Glancey, J. and E. Kee. 1999. Report on the throughput capacities and recovery characteristics of tractor mounted and pull-type cucumber harvesters.
9. Kee, E. and J. Glancey. 1997. Harvest loss in peas and lima beans with pod stripper combines.
10. Kee, E., T. Wootten, and J. Glancey. University of Delaware Pea Variety Trials. 1996, 1997, 1998, 2000, 2002.

Presentations & Demonstrations at Cooperative Extension and Other Outreach Meetings

1. Multiple Updates on the Delmarva N and P mass balance as part of the Land and Litter Challenge. (2017). L&L Steering Committee Meeting, Wye, MD.

2. Irrigating Agricultural Crops with Treated Municipal Wastewater: Review of a Three Year Study and New Regulations in Delaware. 2014. STAC meeting of the Center for the Inland Bays, Lewes, DE.
3. Latest in baler technology and bale size economics. 2014. Delaware Ag Week, Harrington, DE.
4. Updates on the next version of the EPA model to predict nutrient loading in the Chesapeake Bay from the poultry industry. 2014. Delaware Ag Week, Harrington, DE.
5. Latest in baler technology and bale size economics. 2014. Southern Maryland Hay & Pasture Conference, Brandywine, MD.
6. Moisture sensing technologies for hay production. 2013. Delaware Ag Week, Harrington, DE.
7. Recommendations for the Reuse of Treated Municipal Wastewater for Irrigating Crops. 2013. 2013 Mid-Atlantic Crop Management School, Ocean City, MD.
8. Moisture sensing technologies for hay production. 2013. Southern Maryland Hay & Pasture Conference, Brandywine, MD.
9. Moisture sensing technologies for hay production. 2013. Tri-State Hay & Pasture Conference, Oakland, MD.
10. Environmental pressures on small vegetable processors- a case study for lima bean grading. 2013 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
11. As Needed Irrigation with Municipal Wastewater: A Pilot Project for the Town of Middletown. 2012. Delaware Ag Week, Harrington, DE.
12. Irrigating with Highly Treated Municipal Wastewater: Feasibility for Vegetables? 2012 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
13. Drip irrigation basics demonstration. 2010. Twilight meeting for New Castle County growers. (with Anna Stoops, Extension Agriculture Agent).
14. Moderator of a grower and dealer panel—Irrigation Engineering Advances and Water Conservation. 2010. Irrigation Session, Delaware Ag Week, Harrington, DE.
15. Season extenders: row covers, greenhouses, high and low tunnels and cold frames. 2010. Delaware Organic food and Farming Association Annual Educational Meeting. Dover, DE.
16. Compaction in processing vegetable fields: causes and cures. 2009. Delaware Ag Week, Harrington, DE.
17. Technologies for Manure Management. 2009 Delmarva Dairy Day. Hartley, DE.
18. Energy efficiency of alternative fuels and tips for saving energy on the farm. 2008. Agronomy/Soybean Session, Delaware Ag Week, Harrington, DE.
19. Nutrient management considerations for various tillage systems. 2008. Nutrient Management Session, Delaware Ag Week, Harrington, DE.
20. Facility considerations for Delaware dairy farms. 2008 Delmarva Dairy Day, Harrington, DE
21. Panel member: Discussion on cover crops, irrigation, tillage practices and nutrient management. 2008 Delmarva Dairy Day, Harrington, DE
22. Machine setup and operation for optimal quality forage. 2007. The 2007 Mid-Atlantic Crop Management School, Ocean City, MD.
23. GPS and precision agriculture applications for agronomic and vegetable crops grown in the Delmarva region. 2007. The Southern States Cooperative Growmaster Annual Training Program, Harrington, DE.
24. Composite-based tool designs to reduce vibration and noise. 2007. The Delaware Woodworkers Guild Meeting, Glasgow, DE.
25. Maintenance, adjustment, and operation of mower-conditioners to minimize drying time and dry matter losses in hay production. 2007. Southern and Central Maryland Hay and Pasture Conference. Waldorf, MD.
26. Harvest recovery of a band saw cutter for spinach and several small greens. 2007 Delaware Ag Week, Harrington, DE.
27. Maintenance, adjustment, and operation of mower-conditioners to minimize drying time and dry matter losses in hay production, 2007 Delaware Ag Week (both day and night programs), Harrington, DE.
28. Performance and recovery characteristics of a band saw cutter for spinach and several small greens. 2006 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
29. Design of a continuous blade cutter for processing spinach. 2006. Delaware Ag Week, Harrington, DE.
30. GPS contest. 2005 Day on the Farm, Hockessin, DE.
31. Design and safety concerns with the new bandsaw-type spinach harvester. 2005 Mid-Atlantic Vegetable Workers Conference, Newark, DE.
32. How to use GPS waypoints to identify and find hidden objects. 2004 Day on the Farm, Middletown, DE.
33. Biodiesel: Facts and fiction. 2004. 2004 Agronomy Days. Delaware Cooperative Extension. Harrington, DE.
34. Update on commercialization of bio-based fuels and lubricates & considerations for road and off-road vehicles. 2004. Delaware Vegetable Growers Association, Harrington, DE.

35. Application machinery and technology considerations for cost-effective nutrient management. 2004. The 2004 Mid-Atlantic Crop Management School, Ocean City, MD.
36. GPS technology demonstration and GPS challenge contest. 2003. Farm and Home Field Day, Georgetown, DE.
37. How to choose, use and not abuse hydraulic systems and fluids. 2003. Delaware Agronomy and Machinery Day, Harrington, DE
38. Design and development of detachable cutter knives for high speed disc cutter bars. 2002. Delaware Vegetable Growers Association (with Dawn Cintavey, W.L. Gore and Associates, Inc.), Harrington, DE.
39. Yield monitoring and precision field mapping in vegetable crops. 2001. Delaware Vegetable Growers Meeting, Felton, DE 2001.
40. Current and future trends in intelligent agricultural machinery, 2001. Delaware Agronomy Day, Harrington, DE.
41. Irrigation system design for the Mid-Atlantic region. 2000. University of Maryland Cooperative Extension Service Winter Growers Meeting. Fair Hill, MD.
42. Yield monitors and new harvesting equipment for processed vegetable production. 2000. The 2000 Mid-Atlantic Crop Management School, Ocean City, MD.
43. Center pivot irrigation system design and economic considerations for Delaware. 1999. Delaware Cooperative Extension Service New Castle County Growers Breakfast Meeting. 1999. St. Georges, DE.
44. Prototype device for sensing watermelon ripeness. Farm and Home Field Day. 1999. Georgetown, DE.
45. Update on Cucumber Harvesting Research. 1999. University of Delaware Grower and Processor Pickling Cucumber Meeting. Georgetown, DE.
46. What's driving precision agriculture in Delaware? 1998. University of Delaware In-Service for Cooperative Extension Professionals. Dover, DE.
47. Irrigation pumping methods and equipment for improved water management. 1998. University of Maryland Cooperative Extension Kent Co. Growers Meeting, Galena, MD.
48. New equipment for irrigation and water resources management. 1998. University of Maryland Wye Research Center, Wye Mills, MD.
49. New technology for vegetable production. Delaware Vegetable Growers Meeting. 1998. Milford, DE.
50. Comparison of the new shaker harvester to conventional harvesters for processed cucumbers. Delaware Vegetable Growers Meeting. 1998. Milford, DE.
51. New technology for irrigation and water management. 1998. Mid-Atlantic Crop Certification School, Dover, DE.
52. Demonstration of a precision manure applicator. 1997. DNREC Crop Management Tour, Sussex County, DE.
53. Techniques for reducing tire-induced soil compaction. 1997. Delaware Vegetable Growers Meeting. Milford, DE.
54. Progress in developing yield monitors for processed vegetables. 1997. Delaware Vegetable Growers Meeting. Milford, DE.
55. Reducing the potential for soil compaction induced with pneumatic tires. 1997. Milford Fertilizer Inc. Annual Field Crops Growers Meeting, Bordentown, NJ.

DELAWARE COOPERATIVE EXTENSION ENGINEERING SERVICES PROJECTS

1. Design of a Tractor Trailer Unloading System for Sweet Corn. Fifer Orchards, Wyoming, DE. (2020-21).
2. Measurement of potato emergence and population in a commercial potato production setting. Pries Farm, Harrington, DE. (2019)
3. Implementation of reclaimed wastewater program at the new Milton, DE wastewater treatment facility for on-demand agricultural irrigation. Artisan Water Co., Inc. (2019-present).
4. The Town of Middletown, Delaware. Middletown, DE. Proposal to Governor Carney and Secretary Garvin (DNREC) for a state-wide review and revision of the regulations governing the treatment and distribution of wastewater in Delaware. (2018-present).
5. The Covered Bridge Inn, Lewes, DE. Design of a radiant infrared heating system for an agricultural barn and reception facility for weddings (Hopkins Dairy Farm). (2017).
6. The Town of Middletown, Delaware. Middletown, DE. Preparation of an amended CMR permit application to recognize agricultural spray-on-demand irrigation as dedicated wastewater disposal capacity in the Middletown region. (2017-18).
7. Puglusi Egg Farm, Middletown, DE. Modifications to the washwater disposal system to achieve compliance with the DNREC operating permit. (2015-16).
8. Howard Webb Farm, Lincoln, DE. Design of a ventilation system and electrical service for a beef holding and finishing building. (2016).
9. Kraft Foods, Inc., Dover, DE. Forensic analysis of high rate of failures on the StoveTop Stuffing manufacturing line. (2013).

10. Kraft Foods, Inc., Dover, DE. Re-design of the drive system for package handling. (2013).
11. New Castle County Wastewater Treatment Division. New Castle, DE. Feasibility calculations for the distribution of highly treated wastewater to the farms surrounding Waterfarm #1 in Odessa. (2013)
12. Delaware Electric Coop. Greenwood, DE. Pollution and energy implications of converting Tier 1, 2, and 3 diesel irrigation pump engines to electric motors. (2013).
13. The Town of Middletown, Delaware. Middletown, DE. Preparation of an amended permit application to expand spray-on-demand in the Middletown region. (2012-14).
14. Duffield and Associates, Pike Creek, DE. Calculation of Ag BMP's nutrient savings for the purpose of nutrient credit trading (2013).
15. The Town of Middletown, Delaware. Middletown, DE. Development and supervision of a bid process for the compaction remediation and re-seeding of the dedicated spray irrigation fields used for wastewater disposal. (2012)
16. Delaware Electric Coop. Greenwood, DE. Computation of PM and NOx emissions from all stationary generators. (2012).
17. Dogfish Head Brewery, Milton, DE. Design of a processing facility to extract juices from local produce as ingredients for beer. (2012-13).
18. Fifer Orchards, Wyoming, DE. Redesign of a sweetcorn packing line for a crew size of 50 packers. (2012-15).
19. The Town of Middletown, Delaware. Middletown, DE. Review of the soil and irrigation management program at the Frog Hollow Golf Course. (2012)
20. West Farms, Milford, DE. Modification of a grading station and development of an amended permit application for DNREC compliance. (2011-14).
21. Delaware Department of Transportation (DelDOT), Georgetown, DE. Design analysis of the hydrostatic drive propulsion system and thruster shaft sealing system on the Delaware Woodland Ferry. (2011-13)
22. Austin & Bednash, Newark, DE. Analysis of the head loss in a dry fire hydrant line & sizing of a primer pump for the hydrant. (2011).
23. Kraft Foods, Inc., Dover, DE. Re-design of the liquid ingredient pumping system for bulk shaved coconut manufacturing. (2011-12).
24. Delaware Department of Transportation (DelDOT), Georgetown, DE. Diagnosis of the misalignment on the loading ramp and redesign of the ramp lifting linkage on the Delaware Woodland Ferry. (2011-12).
25. Artesian Water Company, Inc. Christiana, DE. Nutrient loading limits and water demand for spray on demand irrigation with treated municipal wastewater from Rehoboth Beach, DE. (2011)
26. Delaware Refining Company, LLC., Delaware City, DE. 2011. Feasibility analysis for an ethanol processing facility and a biodiesel processing facility at the Delaware City Refinery. (2011)
27. Aerca Advisors, Wilmington, DE and the Delaware Department of Agriculture, Dover, DE. Development of a power purchase agreement (PPA) between the State of Delaware and a corporation in Delaware. (2011).
28. Chesapeake Utilities, Dover, DE. Feasibility of using natural gas as a replacement for propane for heating poultry houses. (w/ Bill Brown). (2011-12)
29. Lally White, LLP, Lewes, DE & the Delaware Department of Agriculture, Dover, DE. Development of an online knowledge base for the evaluation of solar power systems for agribusinesses. (2011-12)
30. Rolland Hitchens, Georgetown, DE. Calculation of structural member sizes to support extended ballasting weights. (2011).
31. Artesian Water Company, Inc. Christiana, DE. Nutrient loading limits and water demand for spray on demand irrigation with treated municipal wastewater from Rehoboth Beach, DE. (2011)
32. Port of Wilmington, Wilmington, DE. Design recommendations for a 2000 heifer short-term holding facility for loading overseas transportation vessels. (2010-2012)
33. ARCA Advisors and Mid-Atlantic Renewable Parnters LLC (MARP). Feasibility study for large (multi-acre) photovoltaic systems at Perdue (Milford), Mountaire (Millsboro), Vlasic (Millsboro), and Allen's Family Foods (Harbeson). 2010-12.
34. West Farms, Milford, DE. Design of new manufacturing processes and hardware for separating green and white lima beans that reduce Sodium and Chloride concentrations in the wastewater distributed to wastewater spray irrigation systems. (2010-present).
35. Town of Middletown, DE. Drafting of a long-term contract between the growers and town for the use of treated municipal waste water for the irrigation of agricultural crops. (2010-11).
36. Fifer Orchards, Wyoming, DE. Preliminary kWh production estimate and design for a low head turbine-based electrical generation system and dam redesign for the Wyoming pond. (2010-11).

37. L & L Farms, Townsend, DE. Drafting of a lease agreement for renting land for as-needed spray irrigation of agricultural crops with treated and filtered municipal wastewater. (with Anna Stoops, Extension Agriculture Agent). (2010-present)
38. Delaware Department of Agriculture, Dover, DE. 2010. Preliminary sizing for a PV system for the Dover State office. (2010).
39. Coleman's Christmas Tree Farm, Odessa, DE. A Day on the Farm 2010. Promoting agriculture in the state of Delaware –recommendations of land use planning and event volunteer. (2010).
40. Town of Middletown, DE. Recommendations for remediating compaction in dedicated spray irrigation fields owned by municipalities (w/ Anna Stoops, Ext. Ag. Agent). (2010-present)
41. Kranz Farm, Newark, DE. Design of a drip tape or drip emitter system for vegetable production. (with Anna Stoops, Extension Agriculture Agent). (2010).
42. Fifer Orchards, Wyoming, DE. Reconfiguration of a fresh market sweet corn packing line to increase throughput. (2010).
43. Town of Middletown & Artesian Water, Middletown DE. Recommendations for using treated wastewater effluent to irrigate agricultural crops. (2009-present).
44. Delaware Department of Agriculture, Dover, DE. 2010. PV system design and costing for the Redden State Facility in Georgetown, DE.
45. Howard Webb, Milford, DE. Design and configuration of a slatted floor beef facility. (2009)
46. Vogl Farms, Harrington, DE. Design of a structure for a new young animal housing. (2008-09).
47. Carlisle Farms, Greenwood, DE. Design and fabrication of steel drive pulleys for band saw type greens cutters. (2008).
48. Fifer Orchards, Wyoming, DE. Redesign of the hydrocooler water pumping and cleaning systems to reduce heat exchanger fouling. (2008).
49. Seaford High School. Structural analysis and wind load certification of a non-engineered greenhouse. (2008).
50. Rolland Hitchens & Hannover Foods Corp, Georgetown, DE. Configuration, calibration, emergence measurements of a grain drill for narrow row, no-till lima bean production. (2008).
51. Fifer Orchards, Wyoming, DE. Design and implementation of processing line modifications to reduce peach and apple fruit bruising during handling and packing. (2007).
52. Blair View Aquaculture Farm and the NRCES. Milford, DE. Design and implementation of a powered, closed-system, rotary drum composter for tilapia mortalities. (2007)
53. Kenny Grading Station, Bridgeville, DE. Paper design of an on-site relish fermentation system – heater sizing and estimate of energy requirements and costs. (2006)
54. H&S DuBoise, Pittgrove, NJ. Design of and recovery measurements for a continuous cutter for small greens. (2006).
55. Blair View Aquaculture Farm, Milford, DE. Design and implementation of a catch-and-weigh system for tilapia harvest. (2005-06).
56. Kenny Grading Station, Bridgeville, DE. Design and installation of a speed reduction drive for a high volume pumping station. (2005).
57. Colemans Tree Farm, Odessa, DE. Irrigation pump and electric motor selection. (2005).
58. Carlisle Farms, Greenwood DE. Installation of a continuous blade spinach cutter header on a Portaway harvester. (2004).
59. Mumford General Contractors, Seaford, DE. Testing protocol for the evaluation of a defective concrete floor. (2004).
60. Carrazza Farms, Townsend, DE. Estimation of fuel consumption for stationary power units for oxygenator recommendations on diesel power units in Delaware. (2004).
61. Blair View Aquaculture Farm, Milford, DE. Design and fabrication of a basket conveyor for live tilapia harvest and loading. (2004-05).
62. Kenny Grading Station, Bridgeville, DE. Finite element analysis and installation of a continuous, long-span, beam-type water line and support structure for the hydro-unloading of cucumber transport trucks. (2004).
63. Woodenhawk Farms, Greenwood, DE. Structural analysis and engineering certification of a greenhouse structure. (2003).
64. L&L Farms, Inc., Middletown, DE. Field measurements and analysis of multiple center pivot irrigation system structural failures. (2001).
65. Gundry Greenhouses, Laurel, DE. Structural analysis and engineering certification of a hoop greenhouse structure. (2000).

66. Richardson's Farm, Hurlock, MD. Design of bridges over drainage ditches for center pivot irrigation systems. (2000).
67. Hitchens Farms, Inc. Georgetown, DE. Field evaluation of an irrigation system end gun reconfiguration for lawsuit settlement. (1999).
68. Carlisle Brothers, Inc., Greenwood, DE. Selection and installation of a fuel flow meter for irrigation system power units. (1999).
69. Holy Hill Farms, Milford, DE. Hydraulic system redesign and installation for a raven cucumber harvester. (1998).
70. Fifer Orchards, Wyoming, DE. Design and setup of a sweet corn grading & packing line with a hydrocooler. (1998-99).
71. Fifer Orchards, Wyoming, DE. Design and setup of a hydraulic drive and unloading system for sweet corn wagons. (1997).
72. Jersey Asparagus Farms, Elmer, NJ. Design and testing of shaker cleaning system for asparagus root crowns. (1997-98).

SERVICE

GOVERNMENT SERVICE

- *Gubernatorial Appointment*, Delaware's Representative on the EPA's Scientific and Technical Advisory Committee (STAC) for the Chesapeake Bay Program. 2011-2014 term.
- *Invited Panel Member*, Congressional Delegations of Delaware and Maryland's Environmental Summit. 2012.
- *Cabinet Secretaries (DNREC & DDA) Appointment*, State Certainty Committee and Program, State of Delaware. 2012-present.
- *Invited Panel Member*, Congressional Delegations of Delaware and Maryland's Environmental Poultry Summit. 2012.
- *Gubernatorial Appointment*, Governor's Energy Advisory Council, State of Delaware. 2009-2012 term.
- *Cabinet Secretaries (DNREC & DDA) Appointment*, State Technical Standards Committee, State of Delaware. 2010-present.
- *Invited Member*, Planning & Advisory Committee for the Town of Middletown Wastewater Treatment Facility Expansion Project. 2009-present.
- *Invited Panel Member*. Forum on Expanding the U.S. Biofuels Market. USDA/Rural Development/Farm Services Agencies (FSA). 2010-11.

PROFESSIONAL & INDUSTRIAL SERVICE

- *Member*, Advisory Board for EzyCure LLC (DE small business growing and processing medical hemp), Harrington, DE. 2020-present.
- *Member*, Land and Litter Challenge, Subcommittee on the Mass Balance of Nitrogen and Phosphorous on Delmarva. 2016-2018.
- *Invited Member*, Chesapeake Bay Programs' Implementation Workgroups. Agriculture Workgroup & Watershed Technical Workgroup. 2011-present.
- *Chair*, Chesapeake Bay Programs' Sub-committee on Quantifying Nutrient Generation by the Poultry Industry within the Chesapeake Bay Watershed (aka the Poultry Litter Subcommittee). (2011-16).
- *Chairman, Vice-Chair, and Past-Chair* of PM48 – Fruit and Vegetable Production Engineering. ASAE. 1999-2005.
- *Executive Committee Member and University Relations Officer*, Delaware Section of the American Society of Mechanical Engineers. 2003-2016.
- *National Science Foundation Invited Workshop Participant*: Engineering Solutions for Sustainable Food and Energy Supplies in the U.S. Co-Sponsored by NSF, NASA, and USDA. April 24-25, 2007, Washington, DC.
- *Scientific Committee Member*, International Symposium on the Application of Precision Agriculture for Fruits and Vegetables. 2007-08.
- *National Science Foundation Invited Workshop Presenter and Participant*: Future of Modeling in Composites Molding Processes. Co-Sponsored by NSF, DOE and APC, June 9-10, 2004, Washington, DC.
- *Member*, United Soybean Board National Technical Advisory Panel for Industrial Uses of Soybean Oil. (1999-2001).
- *Member*, ASAE PM 04 - Power and Machinery Publications Committee. 2003-present.
- *Member*, ASAE PM 01/02 - Power and Machinery Executive Steering Committee. 2001-2003.

- *ASABE Technical Committee Memberships*: PM 48 – Fruit and Vegetable Production Engineering (1996-present); PM 54 – Precision Agriculture (1998-99); PM 51 – Hydraulics (1998-00); ESH 04 – Ergonomics, Safety and Health (2003-present)
- *Member*, Scientific and Technical Advisory Committee, Center for the Inland Bays, Lewes, DE 2004-present.
- *SAE Technical Committee Memberships*: Alternate Industrial Lubricants (1997-00); Fluid Power (1997-99); Farm Equipment (1997-99, 2003-present)
- *ASME Committee Memberships*: Reliability, Stress Analysis and Failure Prevention Technical Committee (RSAFP) (2003-present)
- *Chair and/or Moderator*, Sessions at Professional Meetings
  - 2008 Conference on Application of Precision Agriculture for Fruits and Vegetables, Session on *Economics, Quality and Environmental Aspects of Precision Agriculture*.
  - 2007 Greater Philadelphia AIAA/ASME 3rd Annual Aerospace/Mechanical Engineering Mini-Symposium, Session on *Materials*.
  - 2007 ASABE International Annual Meeting – Session ESH-4, *Agricultural Safety and Health – Education and Intervention.*
  - 2006 ASABE International Annual Meeting – Session ESH 216, *Advances in Safety Technology*.
  - 2004 SAE Commercial Vehicle Engineering Congress and Exposition – *Advances in Off-Road Vehicle Electronics*.
  - 2001 ASAE International Annual Meeting – Session 112 – *New Technology for Fruit and Vegetable Production Engineering*.
  - 1999 SAE Off-Highway and Powerplant Congress and Exposition – *Alternative Industrial Lubricants.*
- *Reviewer*, Manuscripts
  - Journal of Mechanical Design, Transactions of the American Society of Mechanical Engineers (2).
  - Journal of Composites, Part A: Applied Science Manufacturing (4).
  - Journal of Sandwich Structures and Materials (3)
  - Peer-Reviewed Proceedings of the Design Engineering Technical Conference (2005) – Symposium on Reliability, Stress, and Failure Prediction (American Society of Mechanical Engineers) (2).
  - Peer-Reviewed Proceedings of Society for the Advancement of Materials and Processes (SAMPE) (1).
  - Peer-Reviewed Proceedings of the American Society of Mechanical Engineers Congress (2)
  - Peer-Reviewed Proceedings of the Design Engineering Technical Conference (2008) – 5th Symposium on International Design and Design Education (American Society of Mechanical Engineers) (3).
  - Transactions of the American Society of Agricultural Engineers (6)
  - Computers and Electronics in Ag (1)
  - Journal of Agricultural Engineering Research (1)
  - Biosystems Engineering (3)
  - Applied Engineering in Agriculture (7)
  - Canadian Journal of Bio-Engineering (1)
  - SAE Technical Papers (4)
  - HortTechnology (ASHS) (4)
  - Special Issue of Soil and Tillage Research (1)
  - Journal of Irrigation and Drainage Engineering, American Society of Civil Engineers (1)
  - USDA Peer-Reviewed Publications (1)
- *Reviewer*, Books
  - *Design of Machinery*, *5th Edition.* McGraw Hill, New York, NY
  - *Mechanical Engineering Design*, 8th Edition. McGraw Hill, New York, NY
  - *Solid Works Workbook*. Prentice Hall, Upper Saddle River, NJ.
  - *Practical Reliability Analysis*. Prentice Hall Publishing, Upper Saddle River, NJ.
  - *Machine Design Series*. John Wiley & Sons, Inc., Hoboken, NJ
- *Reviewer*, Proposals
  - Kentucky Science and Engineering Foundation, R & D Excellence Funding Program (2006).
  - Canadian Natural Sciences and Engineering Research Council (NSERC) (2006).
  - The Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) – Environmental Technology Development Grants Program (2004).
  - Canadian Natural Sciences and Engineering Research Council (NSERC) (2002).
  - National Review Panel, Small Business Innovative Research Program, Washington, D.C. (1999).

- Small Business Innovative Research Program, Proposal Reviewer (1998, 1999, 2000, 2001, 2002, 2003, 2006, 2007, 2008).
- *Reviewer*, Papers for Northeast Agricultural and Biological Engineers (NABEC) Student Design Competition. (1992-2004, 2006, 2009, 2010).
- *Proctor*, Delaware Association of Professional Engineers. Fundamentals of Engineering Exam. (1998, 1999).

UNIVERSITY SERVICE

- *Advisor*, UD Trap and Skeet Club. (2017-2020).
- *Member*, UD Sustainability Fund Working Group. (2011-2013 term)
- *Member*, Advisory Panel for the Undergraduate Research Program (2009-13).
- *Member*, Senior Thesis Board, Undergraduate Research Program. (2003-13).
- *Instructor of Record*, Undergraduate Senior Thesis (UNIV 401 and 402). (2007-08).
- *Co-Advisor*, Solar Decathlon Competition. (2001-2003).
- *Member*, Search Committee for Project Manager in the Office of the Vice Provost for Research. (1999-2000).
- *Member*, Search Committee for Assistant Project Manager in the Office of the Vice Provost for Research. (1999).
- *Member*, Undergraduate Studies Committee, Faculty Senate (1995-97).

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES (CANR) SERVICE

- *Member*, Nutrient Management Committee (2012-13).
- *Member*, Search Committee for the Dean, College of Agriculture and Natural Resources (2012).
- *Member*, Search Committee for CANR Nutrient Management Faculty Member and Specialist (2012).
- *Member*, Search Committee for CANR Extension Environmental Quality and Management Specialist (2012).
- *Member*, Search Committee for CANR Newark Farm Manager (2008-10).
- *Member*, Search Committee for the Extension Vegetable Specialist. (2007-09).
- *Member*, College Promotion and Tenure Committee (2003-2005).
- *Member*, Advisory Committee for the CANR Industrial Partnership Program. (2003, 2005-present).
- *Member*, Search Committee for Animal and Food Sciences Assistant Professor - Food Processing. (2003).
- *Member*, Search Committee for CANR Associate Dean for Education and Research. (2003).
- *Member*, Search Committee for CANR Newark Farm Manager (2002).
- *Member*, Search Committee for Animal and Food Sciences Assistant Professor - Food Engineer (2002).
- *Member*, Review Committee for the CANR Research Partnership Program. (2001, 2005).
- *Member*, College Promotion and Tenure Committee (2000-2002).
- *Member*, Deans Advisory Committee (2000-2001).
- *Co-Host*, Delaware Vegetable Growers Trip to the Tulare Farm Show (w/ Ed Kee). (1999).
- *Member*, College Committee on Nutrient Management. (1998).
- *Member*, College Strategic Planning Committee (1997-98).

COLLEGE OF ENGINEERING (COE) SERVICE

- *Member*, Search Committee – CAD/CAM Machinist for the COE Student Machine Shop. (2021-22).
- *Advisor*, Solar Decathlon College of Engineering Team. (2019-21)
- *Member*, Search Committee – Laboratory Coordinator for Mechanical Engineering. (2018).
- *Faculty Manager and Coordinator*, Student Machine Shop. (2016-present)
- *Member*, Search Committee – CNC and CAD/CAM Master Machinist for the Student Machine Shop. (2017).
- *Member*, Search Committee – Replacement Master Machinist for the Colburn Research Machine Shop. (2017).
- *Faculty Consultant*, Reconfiguration of the Colburn Machine Shop Lathe Lifts (2010).
- *Member*, Advisory Committee for the Society of Automotive Engineers Club (2009-10).
- *Member*, Center for Composites Materials Honors Day Awards Committee (2004, 2007).
- *Member*, Search Committee - Master Machinist for the Student Shop. (2003).
- *Moderator*, Center for Composites Spring and Summer Research Symposiums (Fall, 2003, Spring, 2004, Spring 2005, Spring 2007, Spring 2008, Spring 2009, Spring 2010)
- *Faculty Coordinator*, Renovations of the Student Shop and Student Shop Website (2001–2004).

DEPARTMENT OF BIORESOURCES ENGINEERING SERVICE

- *Chair*, Promotion and Tenure Committee. (2012-13)

- *Member*, Promotion and Tenure Committee. (2007-08)
- *Chair*, Promotion and Tenure Committee. (2006-07)
- *Presenter*, RISE Program Presentation to High School Students. (Fall 2003, Spring 2004)
- *Member*, Department Promotion and Tenure Committee. (2001-02).
- *Member*, Search Committee for Assistant Professor/Extension in Irrigation/Water Resources Engineering (2000-01).
- *Member*, Search Committee for Assistant Professor/Extension Specialist in Poultry Production Engineering (2000-01).
- *Member*, Search Committee for Assistant Professor in Power and Machinery, Bioresources Engineering (2000).
- *Member*, Search Committee for Engineering Extension Associate. (1999).

Department of Mechanical Engineering Service

- Member, Graduate Student-Industry Partnership (GSIP) Program (2018-present)
- *Chair*, ME Safety Committee (2017-18, 2018-19).
- *Member*, Planning Committee for the Future of Design Instruction (2009).
- *Member*, Design Curriculum Committee. (2005).
- *Member*, Laboratory Committee. (2000- present).
- *Advisor*, Student Chapter of SAE. (2000-01).
- *Member*, Graduate Student Recruitment Committee. (1999-00).

Exhibit B

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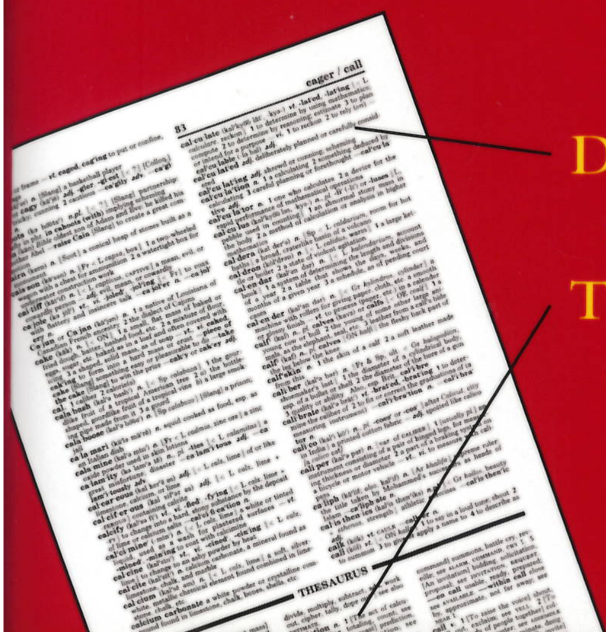

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coun'ter·clock'wise' *adj., adv.* in a direction opposite to that in which the hands of a clock move
coun'ter·cul'ture *n.* a culture with a lifestyle that is opposed to the prevailing culture
coun'ter·es'pi·o·nage' *n.* actions to prevent or thwart enemy espionage
coun'ter·feit' (-fit') *adj.* [< OFr *contre-*, counter- + *faire*, to make] **1** made in imitation of something genuine so as to deceive; forged **2** sham; pretended —*n.* an imitation made to deceive; forgery —*vt.*, *vi.* **1** to make an imitation of (money, etc.), usually to deceive **2** to pretend —**coun'ter·feit'er** *n.*
count'er·man' (-man') *n., pl.* **-men'** (-men') a man who serves customers at a counter, as of a lunchroom
coun'ter·mand' (-mand') *vt.* [< L *contra*, against + *mandare*, to command] to cancel or revoke by a contrary order
coun'ter·mel'o·dy *n.* a melody distinct from the principal melody
coun'ter·pane' (-pān') *n.* [ult. < L *culcita puncta*, embroidered quilt] a bedspread
coun'ter·part' *n.* **1** one that closely resembles another **2** a copy or duplicate
coun'ter·point' *n.* [< It: see COUNTER- & POINT] **1** the technique of combining two or more distinct lines of music that sound simultaneously **2** any melody played or sung against a basic melody **3** a thing set up in contrast with another
coun'ter·poise' *n.* [see COUNTER² & POISE] **1** a counterbalance **2** equilibrium —*vt.* **-poised'**, **-pois'ing** to counterbalance
coun'ter·pro·duc'tive *adj.* having results contrary to those intended
coun'ter·rev'o·lu'tion *n.* a political movement against a government set up by a previous revolution —**coun'ter·rev'o·lu'tion·ar'y**, *pl.* **-ies**, *n., adj.*
coun'ter·sign' *n.* **1** a signature added to a previously signed document, as for confirmation **2** a secret signal to another, as a password —*vt.* to confirm with one's own signature
coun'ter·sink' *vt.* **-sunk'**, **-sink'ing** **1** to enlarge the top part of (a hole) so that the head of a bolt, etc. will fit flush with the surface **2** to sink (a bolt, etc.) into such a hole
coun'ter·ten'or *n.* **1** the range of the highest male voice, above tenor **2** a voice or singer with such a range
count'er·top' *n.* the upper surface of a COUNTER¹ (sense 4)
coun'ter·weight' *n.* a counterbalance
count·ess (kount'is) *n.* **1** the wife or widow of a count or earl **2** a woman of nobility with a rank equal to that of a count or earl
count·less (kount'lis) *adj.* too many to count; innumerable; myriad
coun·try (kun'trē) *n., pl.* **-tries** [< L *contra*, against] **1** an area of land; region **2** the whole land, or the people, of a nation **3** the land of one's birth or citizenship **4** land with farms and small towns **5** *short for* COUNTRY MUSIC
country club a social club with a clubhouse, golf course, etc.
coun'try·man (-mən) *n., pl.* **-men** (-mən) a person of one's own country
country music popular music that derives from the rural folk music of the S U.S.
coun'try·side' *n.* a rural region
coun'try·wide' *adj., adv.* throughout the entire nation
coun·ty (kount'ē) *n., pl.* **-ties** [< ML *comitatus*, jurisdiction of a count] a small administrative district of a country, U.S. state, etc.
coup (ko͞o) *n., pl.* **coups** (ko͞oz) [Fr < L *colaphus*, a blow] **1** a sudden, successful action **2** COUP D'ÉTAT
coup de grâce (ko͞o' də gräs') [Fr, stroke of mercy] **1** the blow, shot, etc. that brings death to a sufferer **2** a finishing stroke
coup d'é·tat (ko͞o' dā tä') [Fr, stroke of state] the sudden, forcible overthrow as of a ruler or government
coupe (ko͞op) *n.* [< Fr *couper*, to cut] a closed, two-door automobile
cou·ple (kup'əl) *n.* [< L *copula*] **1** a link **2** a pair of things or persons, as a man and woman who are engaged, married, etc. **3** [Inf.] a few —*vt.*, *vi.* **-pled**, **-pling** to link or unite
cou·plet (kup'lit) *n.* two successive lines of poetry, esp. two that rhyme
cou·pling (kup'liŋ) *n.* **1** a joining together **2** a mechanical device for joining parts together
cou·pon (ko͞o'pän', kyo͞o'-) *n.* [Fr < *couper*, to cut] **1** a detachable printed statement on a bond, specifying the interest due at a given time **2** a certificate entitling one to a specified right, as a discount or gift
cour·age (kur'ij) *n.* [< L *cor*, heart] the quality of being brave; valor
cou·ra·geous (kə rā'jəs) *adj.* having or showing courage; brave —**cou·ra'geous·ly** *adv.*
cou·ri·er (ko͝or'ē ər, kur'-) *n.* [< L *currere*, to run] a messenger
course (kôrs) *n.* [< L *currere*, to run] **1** an onward movement; progress **2** a way, path, or channel **3** the direction taken **4** a regular manner of procedure or conduct *[our wisest course]* **5** a series of like things in order **6** a part of a meal served at one time **7** *Educ.* *a)* a complete series of studies, as for a degree *b)* any of the separate units of such a series —*vi.* **coursed**, **cours'ing** to run or race —**in due course** in the usual sequence (of events) —**in the course of** during —**of course** **1** naturally **2** certainly
cours·er (kôr'sər) *n.* a graceful, spirited, or swift horse
court (kôrt) *n.* [< L *cohors*, enclosure] **1** a courtyard **2** a short street **3** a space for playing a game, as basketball **4** *a)* the palace, or the family, etc., of a sovereign *b)* a

THESAURUS

counterfeit *a.* sham, spurious, fictitious; see FALSE 3.
counterfeit *v.* make counterfeit money, coin (British), make funny money*, circulate bad money; see also FORGE.
counterfeiter *n.* forger, paperhanger*, plagiarist; see CRIMINAL.
countless *a.* innumerable, incalculable, numberless; see INFINITE, MANY.
country *a.* **1** [*Said of people*] rural, homey, unpolished; see IGNORANT 2, RUDE 1. **2** [*Said of areas*] rustic, agrarian, provincial; see RURAL.
country *n.* **1** [Rural areas] farms, farmland, farming district, rural region, rural area, range, country district, backcountry, bush, forests, woodlands, backwoods, sparsely settled areas, sticks*, the boondocks*, boonies*; see also FARM, FOREST.—*Ant.* CITY, borough, municipality. **2** [A nation] government, a people, a sovereign state; see NATION 1. **3** [Land and all that is associated with it] homeland, native land, fatherland; see LAND 2.
countryside *n.* rural district, farmland, woods; see COUNTRY 1.
county *n.* province, constituency, shire; see AREA, REGION 1.
couple *n.* **1** [A pair] two, set, brace; see PAIR. **2** [*A few] two, several, a handful; see FEW.
couple *v.* unite, come together, link; see COPULATE, JOIN 1.
coupon *n.* token, box top, order blank, detachable portion, premium certificate, ticket; see also CARD, TICKET 1.
courage *n.* bravery, valor, boldness, fearlessness, spirit, audacity, audaciousness, temerity, manliness, pluck, mettle, enterprise, stoutheartedness, firmness, self-reliance, hardihood, heroism, gallantry, daring, prowess, power, resolution, dash, recklessness, defiance, the courage of one's convictions, spunk*, grit, backbone, guts*, what it takes*, moxie*, nerve; see also STRENGTH.—*Ant.* FEAR, cowardice, timidity.
courageous *a.* daring, gallant, intrepid; see BRAVE.
course *n.* **1** [A route] passage, path, way; see ROUTE 1. **2** [A prepared way, especially for racing] lap, cinder path, track; see ROAD 1. **3** [A plan of study] subject, studies, curriculum; see EDUCATION 1. **4** [A series of lessons] classes, lectures, seminar; see EDUCATION 1. —**in due course** in due time, properly, conveniently; see APPROPRIATELY. —**in the course of** during, in the process of, when; see WHILE 1. —**of course** certainly, by all means, indeed; see SURELY. —**off course** misdirected, erratic, going the wrong way; see WRONG 2. —**on course** on target, correct, going in the right direction; see ACCURATE 2.
court *n.* **1** [An enclosed, roofless area] square, courtyard, patio; see YARD 1. **2** [An instrument for administering justice] tribunal, bench, magistrate, bar, session. *Types of courts include the following:* the Supreme Court of the United States, appellate court of the United States, federal court, state supreme court, district court, county court, justice's court, magistrate's court, mayor's court, police court. **3** [A sovereign's family, attendants, etc.] lords and ladies, attendants, royal household; see GOVERNMENT 2, ROYALTY, RULER 1. **4** [An area for playing certain games] arena, rink, ring; see FIELD 2.
court *v.* attract, allure, solicit, beseech, entice, pursue, accompany, follow, plead, make love, pay court, pay attentions to, pay court to, make

se·crete (si krēt′) *vt.* **-cret′ed, -cret′ing** [see SECRET] **1** to hide; conceal **2** to form and release (a substance) as a gland, etc. does

se·cre·tion (si krē′shən) *n.* **1** a secreting **2** a substance secreted by an animal or plant

se·cre·tive (sē′krə tiv) *adj.* concealing one's thoughts, etc.; not frank or open —**se′cre·tive·ly** *adv.* —**se′cre·tive·ness** *n.*

se·cre·to·ry (si krēt′ər ē) *adj.* having the function of secreting, as a gland

Secret Service a division of the U.S. Treasury Department for uncovering counterfeiters, guarding the President, etc.

sect[1] (sekt) *n.* [< L *sequi*, follow] **1** a religious denomination **2** any group of people having a common philosophy, set of beliefs, etc.

sect[2] *abbrev.* section

sec·tar·i·an (sek ter′ē ən) *adj.* **1** of or devoted to some sect **2** narrow-minded —*n.* a sectarian person —**sec·tar′i·an·ism′** *n.*

sec·tion (sek′shən) *n.* [< L *secare*, to cut] **1** a cutting or cutting apart **2** a part cut off; portion **3** any distinct part, group, district, etc. **4** a drawing, etc. of a thing as it would appear if cut straight through —*vt.* to divide into sections

sec′tion·al *adj.* **1** of or characteristic of a given section or district **2** made up of sections —**sec′tion·al·ism′** *n.*

sec·tor (sek′tər) *n.* [< L *secare*, to cut] **1** part of a circle bounded by any two radii and the included arc **2** any of the districts into which an area is divided for military operations **3** a distinct part of society or of an economy, group, etc.

sec·u·lar (sek′yə lər) *adj.* [< LL *saecularis*, worldly] not religious; not connected with a church —**sec′u·lar·ism′** *n.*

sec′u·lar·ize′ (-lə rīz′) *vt.* **-ized′, -iz′ing** to change from religious to civil use, control, influence, etc. —**sec′u·lar·i·za′tion** *n.*

se·cure (si kyoor′) *adj.* [< L *se-*, free from + *cura*, care] **1** free from fear, care, etc. **2** free from danger, risk, etc.; safe **3** firm, stable, etc. [*make the knot secure*] —*vt.* **-cured′, -cur′ing** **1** to make secure; protect **2** to make certain, as with a pledge **3** to make firm, fast, etc. **4** to obtain or bring about —**se·cure′ly** *adv.*

se·cu·ri·ty (si kyoor′ə tē) *n., pl.* **-ties** **1** a feeling secure; freedom from fear, doubt, etc. **2** protection; safeguard **3** something given as a pledge of repayment, etc. **4** [*pl.*] bonds, stocks, etc. **5** a private police force

secy or **sec'y** *abbrev.* secretary

se·dan (si dan′) *n.* [< ? L *sedere*, to sit] an automobile with two or four doors, a permanent rigid top, and a full-sized rear seat

se·date[1] (si dāt′) *adj.* [< L *sedare*, to settle] calm or composed; esp., serious and unemotional —**se·date′ly** *adv.*

se·date[2] (si dāt′) *vt.* **-dat′ed, -dat′ing** to dose with a sedative —**se·da′tion** *n.*

sed·a·tive (sed′ə tiv) *adj.* [see SEDATE[1]] tending to soothe or quiet; lessening excitement, irritation, nervousness, etc. —*n.* a sedative medicine

sed·en·tar·y (sed′′n ter′ē) *adj.* [< L *sedere*, to sit] marked by much sitting

Se·der (sā′dər) *n., pl.* **Se·dar·im** (sə där′im) or **Se′ders** [Heb lit., arrangement] [*also* **s-**] *Judaism* the feast of Passover as observed in the home on the eve of the first (by some also of the second) day of the holiday

sedge (sej) *n.* [OE *secg*] a coarse, grasslike plant growing in wet ground

sed·i·ment (sed′ə mənt) *n.* [< L *sedere*, sit] **1** matter that settles to the bottom of a liquid **2** *Geol.* matter deposited by water or wind

sed′i·men′ta·ry (-men′tər ē) *adj.* **1** of or containing sediment **2** formed by the deposit of sediment, as certain rocks

sed′i·men·ta′tion (-men tā′shən, -mən-) *n.* the depositing of sediment

se·di·tion (si dish′ən) *n.* [< L *sed-*, apart + *itio*, a going] a stirring up of rebellion against the government —**se·di′tion·ist** *n.* —**se·di′tious** *adj.*

se·duce (si do͞os′) *vt.* **-duced′, -duc′ing** [< L *se-*, apart + *ducere*, to lead] **1** to tempt to wrongdoing **2** to entice into having, esp. for the first time, illicit sexual intercourse —**se·duc′er** *n.* —**se·duc′tion** (-duk′shən) *n.* —**se·duc′tive** *adj.* —**se·duc′tress** (-tris) *fem.n.*

sed·u·lous (sej′oo ləs) *adj.* [L *sedulus*] diligent

se·dum (sē′dəm) *n.* [< L] a perennial plant found on rocks or walls, with white, yellow, or pink flowers

see[1] (sē) *vt.* **saw, seen, see′ing** [OE *seon*] **1** to get knowledge of through the eyes; look at **2** to understand **3** to learn; find out **4** to experience **5** to make sure [*see* that he goes] **6** to escort [*see* her to her door] **7** to encounter **8** to call on; consult **9** to receive [too ill to *see* anyone] —*vi.* **1** to have the power of sight **2** to understand **3** to think [let me *see*, who's next?] —**see off** to accompany (someone) to the place from which that person is to depart, as on a journey —**see through** **1** to perceive the true nature of **2** to finish **3** to help through difficulty —**see to** to attend to

see[2] (sē) *n.* [< L *sedes*, a seat] the official seat or jurisdiction of a bishop

seed (sēd) *n., pl.* **seeds** or **seed** [OE *sæd*] **1** *a)* the part of a plant, containing the embryo, from which a new plant can grow *b)* such seeds collectively **2** the source of anything **3** [Archaic] descendants; posterity **4** sperm or semen **5** a seeded contestant —*vt.* **1** to plant with seeds

THESAURUS

secrete *v.* **1** [To hide] conceal, cover, seclude; see DISGUISE, HIDE 1. **2** [To perspire] discharge, swelter, emit; see SWEAT.

secretion *n.* discharge, issue, movement; see EXCRETION, FLOW.

secretive *a.* reticent, taciturn, undercover, with bated breath, in private, in the dark, in chambers, by a side door, under one's breath, in the background, between ourselves, in privacy, in a corner, under the cloak of, reserved.

secretly *a.* privately, covertly, obscurely, darkly, surreptitiously, furtively, stealthily, underhandedly, slyly, behind one's back, intimately, personally, confidentially, between you and me, in strict confidence, in secret, behind the scenes, on the sly, behind closed doors, under the table*, quietly, hush-hush*.—*Ant.* OPENLY, obviously, publicly.

sect[1] *n.* denomination, following, order; see CHURCH 3, FACTION.

section *n.* **1** [A portion] subdivision, slice, segment; see PART 1, SHARE. **2** [An area] district, sector, locality; see REGION 1.

sector *n.* section, district, quarter; see AREA, DIVISION 2.

secure *a.* **1** [Firm] fastened, bound, adjusted; see FIRM 1, TIGHT 1. **2** [Safe] guarded, unharmed, defended; see SAFE 1. **3** [Self-confident] assured, stable, determined; see CONFIDENT.

secure *v.* **1** [To fasten] settle, lock, bind; see FASTEN, TIGHTEN 1. **2** [To obtain] achieve, acquire, grasp; see GET 1.

security *n.* **1** [Safety] protection, shelter, safety, refuge, retreat, defense, safeguard, preservation, sanctuary, ward, guard, immunity, freedom from harm, freedom from danger, redemption, salvation.—*Ant.* DANGER, risk, hazard. **2** [A guarantee] earnest, forfeit, token, pawn, pledge, surety, bond, collateral, assurance, bail, certainty, promise, warranty, pact, compact, contract, covenant, agreement, sponsor, bondsman, hostage; see also PROTECTION 2.—*Ant.* DOUBT, broken faith, unreliability.

sedative *n.* tranquilizer, medication, narcotic; see DRUG, MEDICINE 2.

sediment *n.* silt, dregs, grounds; see RESIDUE.

seduce *v.* decoy, allure, inveigle, entice, abduct, attract, tempt, bait, bribe, lure, fascinate, induce, stimulate, defile, deprave, lead astray, violate, prostitute, rape, deflower, ravish.—*Ant.* PRESERVE, protect, guide.

see[1] *v.* **1** [To perceive with the eye] observe, look at, behold, examine, inspect, regard, view, look out on, gaze, stare, eye, lay eyes on, mark, perceive, pay attention to, heed, mind, detect, take notice, discern, scrutinize, scan, spy, survey, contemplate, remark, clap eyes on*, make out, cast the eyes on, direct the eyes, catch sight of, cast the eyes over, get a load of*. **2** [To understand] perceive, comprehend, discern; see RECOGNIZE 1, UNDERSTAND 1. **3** [To witness] look on, be present, pay attention, notice, observe, regard, heed; see also WITNESS. **4** [To accompany] escort, attend, bear company; see ACCOMPANY. **5** [To have an appointment (with)] speak to, have a conference with, get advice from; see CONSULT, DISCUSS. —**see about** attend to, look after, provide for; see PERFORM 1. —**see through** **1** [To complete] finish up, bring to a successful conclusion, wind up; see COMPLETE, END 1. **2** [To understand] comprehend, penetrate, detect; see UNDERSTAND 1. —**see to** do, attend to, look after; see UNDERSTAND 1.

seed *n.* grain, bulbs, cuttings, ears, tubers, roots; seed corn, seed potatoes, etc. *Seeds and fruits commonly called seeds include the following:* grain, kernel, berry, ear, corn, nut. —**go** (or **run**) **to seed** decline, worsen, run out; see WASTE 3.

seed *v.* scatter, sow, broadcast; see PLANT.

seeding *n.* sowing, implanting, spreading; see FARMING.

Exhibit B


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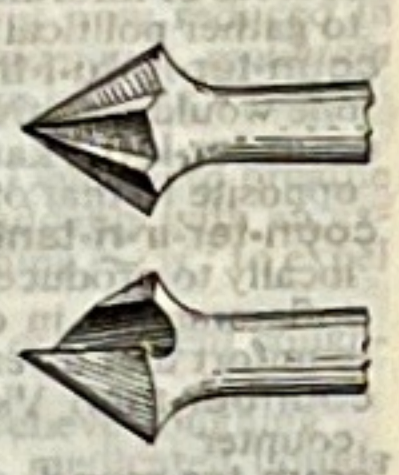
by a previous revolution 2 : a movement to counteract revolutionary trends — **coun·ter·rev·o·lu·tion·ary** \-shə-ˌner-ē\ *adj or n*

coun·ter·shad·ing \ˈkau̇n-tər-ˌshā-diŋ\ *n* (1896) : cryptic coloration of an animal with parts normally in shadow being light and parts normally illuminated being dark thereby reducing shadows and contours

coun·ter·sign \-ˌsīn\ *n* (1591) 1 : a signature attesting the authenticity of a document already signed by another 2 : a sign given in reply to another; *specif* : a military secret signal that must be given by one wishing to pass a guard — **countersign** *vt* — **coun·ter·sig·na·ture** \ˌkau̇n-tər-ˈsig-nə-ˌchu̇r, -chər, -ˌtyu̇r, -ˌtu̇r\ *n*

¹**coun·ter·sink** \ˈkau̇n-tər-ˌsiŋk\ *vt* **-sunk** \-ˌsəŋk\; **-sink·ing** (1816) 1 : to make a countersink on (a hole) 2 : to set the head of (as a screw) at or below the surface

²**countersink** *n* (1816) 1 : a bit or drill for making a funnel-shaped enlargement at the outer end of a drilled hole 2 : the enlargement made by a countersink



countersink 1

coun·ter·spy \ˈkau̇n-tər-ˌspī\ *n* (1939) : a spy engaged in counterespionage

coun·ter·stain \-ˌstān\ *vt* (1895) : to stain (as a microscopy specimen) so as to color parts (as the cytoplasm of cells) not colored by another stain (as a nuclear stain) — **counterstain** *n*

coun·ter·ten·or \-ˌte-nər\ *n* [ME *countretenour* part balancing the tenor, fr. MF *contreteneur*, fr. *contre-* + *teneur* tenor] (15c) : a tenor with an unusually high range (as an alto range)

coun·ter·top \-ˌtäp\ *n* [¹*counter* + ¹*top*] (1897) : the flat working surface on top of waist-level kitchen cabinets

coun·ter·trade \-ˌtrād\ *n* (1976) : a form of international trade in which purchases made by an importing nation are linked to offsetting purchases made by the exporting nation

coun·ter·trans·fer·ence \ˌkau̇n-tər-(ˌ)tran(t)s-ˈfər-ən(t)s, -ˈtran(t)s-(ˌ)\ *n* (1920) 1 : psychological transference esp. by a psychotherapist during the course of treatment; *esp* : the psychotherapist's reactions to the patient's transference 2 : the complex of feelings of a psychotherapist toward the patient

coun·ter·vail \ˌkau̇n-tər-ˈvāl\ *vb* [ME *countrevailen*, fr. AF *cuntrevaloir*, fr. *cuntre-* counter- + *valoir* to be worth, fr. L *valēre* — more at WIELD] *vt* (14c) 1 : to compensate for 2 *archaic* : EQUAL, MATCH 3 : to exert force against : COUNTERACT ~ *vi* : to exert force against an opposing and often bad or harmful force or influence

coun·ter·view \ˈkau̇n-tər-ˌvyü\ *n* (1590) 1 *archaic* : CONFRONTATION 2 : an opposite point of view

coun·ter·weight \-ˌwāt\ *n* (1693) : an equivalent weight or force : COUNTERBALANCE — **counterweight** *vt*

count·ess \ˈkau̇n-təs\ *n* (12c) 1 : the wife or widow of an earl or count 2 : a woman who holds in her own right the rank of earl or count

coun·ti·an \ˈkau̇n-tē-ən\ *n* (15c) : a native or resident of a usu. specified county

count·ing·house \ˈkau̇n-tiŋ-ˌhau̇s\ *n* (15c) : a building, room, or office used for keeping books and transacting business

counting number *n* (ca. 1965) : NATURAL NUMBER

counting room *n* (1712) : COUNTINGHOUSE

count·less \ˈkau̇nt-ləs\ *adj* (1588) : too numerous to be counted : MYRIAD, MANY — **count·less·ly** *adv*

count noun *n* (1952) : a noun (as *bean* or *sheet*) that forms a plural and is used with a numeral, with words such as *many* or *few*, or with the indefinite article *a* or *an* — compare MASS NOUN

count palatine *n* (1539) 1 a : a count of the Holy Roman Empire having imperial powers in his own domain b : a high judicial official in the Holy Roman Empire 2 : the proprietor of a county palatine in England or Ireland

coun·tri·fied *also* **coun·try·fied** \ˈkən-tri-ˌfīd\ *adj* [*country* + *-fied* (as in *glorified*)] (1653) 1 : RURAL, RUSTIC 2 : UNSOPHISTICATED 3 : played or sung in the manner of country music ⟨~ rock⟩

¹**coun·try** \ˈkən-trē\ *n, pl* **countries** [ME *contree*, fr. AF *cuntree*, *contré*, fr. ML *contrata*, fr. L *contra* against, on the opposite side] (13c) 1 : an indefinite usu. extended expanse of land : REGION ⟨miles of open ~⟩ 2 a : the land of a person's birth, residence, or citizenship b : a political state or nation or its territory 3 a : the people of a state or district : POPULACE b : JURY c : ELECTORATE 2 4 : rural as distinguished from urban areas ⟨prefers the ~ to the city⟩ 5 : COUNTRY MUSIC — **coun·try·ish** \-trē-ish\ *adj*

²**country** *adj* (14c) 1 : of, relating to, or characteristic of the country 2 a : of or relating to a decorative style associated with life in the country ⟨an English ~ look⟩; *also* : possessing a style of rustic simplicity ⟨~ furniture⟩ b : prepared or processed with farm supplies and procedures ⟨~ ham⟩ 3 : of, relating to, suitable for, or featuring country music ⟨~ singers⟩

country and western *n* (1960) : COUNTRY MUSIC — usu. hyphenated in attributive use

country–club *adj* (1894) 1 : typical, characteristic, or suggestive of a country club ⟨a ~ atmosphere⟩ ⟨a ~ prison⟩ 2 : having qualities (as affluence) associated with the members of a country club ⟨a ~ conservative⟩

country club *n* (1867) : a suburban club for social life and recreation; *esp* : one having a golf course

coun·try–dance \ˈkən-trē-ˌdan(t)s\ *n* (1579) : any of various native English dances in which partners face each other esp. in rows

country gentleman *n* (1632) 1 : a well-to-do country resident : an owner of a country estate 2 : one of the English landed gentry

country house *n* (14c) : a house and esp. a mansion in the country

coun·try·man \ˈkən-trē-mən, *3 often* -ˌman\ *n* (14c) 1 : an inhabitant or native of a specified country 2 : COMPATRIOT 3 : one living in the country or marked by country ways : RUSTIC

country mile *n* (1950) : a long distance

country music *n* (1952) : music derived from or imitating the folk style of the Southern U.S. or of the Western cowboy

country rock *n* (1968) : rock music containing elements of country music

coun·try·seat \ˌkən-trē-ˈsēt\ *n* (1583) : a house or estate in the country

coun·try·side \ˈkən-trē-ˌsīd\ *n* (1727) 1 : a rural area 2 : the inhabitants of a countryside

coun·try·wide \ˈkən-trē-ˈwīd\ *adj* (1915) : extending throughout a country

coun·try·wom·an \ˈkən-trē-ˌwu̇-mən\ *n* (15c) 1 : a woman who is a compatriot 2 : a woman who is a resident of the country

¹**coun·ty** \ˈkau̇n-tē\ *n, pl* **counties** [ME *counte*, fr. AF *counté*, *counté*, fr. ML *comitatus*, fr. LL, office of a count, fr. *comit-*, *comes* count — more at COUNT] (14c) 1 : the domain of a count 2 a : one of the territorial divisions of England and Wales and formerly also of Scotland and Northern Ireland constituting the chief units for administrative, judicial, and political purposes b (1) : the people of a county (2) *Brit* : the gentry of a county 3 : the largest territorial division for local government within a state of the U.S. 4 : the largest local administrative unit in various countries — **county** *adj*

²**county** *n, pl* **counties** [modif. of MF *comte*] (1550) *archaic* : ³COUNT

county agent *n* (1705) : a consultant employed jointly by federal and state governments to provide information about agriculture and home economics

county court *n* (1639) : a court in some states that has a designated jurisdiction usu. both civil and criminal within the limits of a county

county fair *n* (1856) : a fair usu. held annually at a set location in a county esp. to exhibit local agricultural products and livestock

county palatine *n* (15c) : the territory of a count palatine

county seat *n* (1803) : a town that is the seat of county administration

county town *n* (1670) *chiefly Brit* : COUNTY SEAT

¹**coup** \ˈkōp\ *vb* [ME, to strike, fr. AF *couper* — more at COPE] (ca. 1572) *chiefly Scot* : OVERTURN, UPSET

²**coup** \ˈkü\ *n, pl* **coups** \ˈküz\ [F, blow, stroke — more at COPE] (1791) 1 : a brilliant, sudden, and usu. highly successful stroke or act 2 : COUP D'ÉTAT

coup de grâce *or* **coup de grace** \ˌkü-də-ˈgräs\ *n, pl* **coups de grâce** *or* **coups de grace** \ˌkü-də-\ [F *coup de grâce*, lit., stroke of mercy] (1699) 1 : a deathblow or death shot administered to end the suffering of one mortally wounded 2 : a decisive finishing blow, act, or event

coup de main \-ˈmaⁿ\ *n, pl* **coups de main** \ˌkü-də-\ [F, lit., hand stroke] (1758) : a sudden attack in force

coup d'état *or* **coup d'etat** \ˌkü-(ˌ)dā-ˈtä, ˈkü-(ˌ)dā-ˌ, -də-\ *n, pl* **coups d'état** *or* **coups d'etat** \-ˈtä(z), -ˌtä(z)\ [F, lit., stroke of state] (1646) : a sudden decisive exercise of force in politics; *esp* : the violent overthrow or alteration of an existing government by a small group

coup de thé·âtre *or* **coup de the·atre** \ˌkü-də-tā-ˈätrᵊ\ *n, pl* **coups de théâtre** *or* **coups de theatre** \ˌkü-də-\ [F *coup de théâtre*, lit., stroke of theater] (1747) 1 : a sudden sensational turn in a play; *also* : a sudden dramatic effect or turn of events 2 : a theatrical success

coup d'oeil \kü-ˈdə(r), -ˈdə-ē, -ˈdœ-yə\ *n, pl* **coups d'oeil** *same*\ [F, lit., stroke of the eye] (1739) : a brief survey : GLANCE

cou·pé *or* **coupe** \kü-ˈpā, *2 often* ˈküp\ *n* [F *coupé*, fr. pp. of *couper* to cut, strike] (1825) 1 : a four-wheeled closed horse-drawn carriage for two persons inside with an outside seat for the driver in front 2 *usu* *coupe* : a 2-door automobile often seating only two persons; *also* : one with a tight-spaced rear seat — compare SEDAN

¹**cou·ple** \ˈkə-pəl; *"couple of" is often* ˌkə-plə(v)\ *n* [ME, pair, bond, fr. AF *cuple*, fr. L *copula* bond, fr. *co-* + *apere* to fasten — more at APT] (13c) 1 a : two persons married, engaged, or otherwise romantically paired b : two persons paired together 2 : PAIR, BRACE 3 : something that joins or links two things together: as a : two equal and opposite forces that act along parallel lines b : a pair of substances that in contact with an electrolyte participate in a transfer of electrons which causes an electric current to flow 4 : an indefinite small number : FEW ⟨a ~ of days ago⟩ — **cou·ple·dom** \-dəm\ *n*

²**cou·ple** \ˈkə-pəl\ *vb* **cou·pled**; **cou·pling** \-p(ə-)liŋ\ *vt* (13c) 1 a : to connect for consideration together b : to join for combined effect 2 a : to fasten together : LINK b : to bring (two electric circuits) into such close proximity as to permit mutual influence 3 : to join in marriage or sexual union ~ *vi* 1 : to unite in sexual union 2 : JOIN 3 : to unite chemically

³**couple** *adj* (1924) : TWO; *also* : FEW — used with *a* ⟨a ~ drinks⟩

usage The adjective use of *a couple*, without *of*, has been called nonstandard, but it is not. In both British and American English it is standard before a word (as *more* or *less*) indicating degree ⟨a *couple* more examples of Middle English writing —Charles Barber⟩. Its use before an ordinary plural noun is an Americanism, common in speech and in writing that is not meant to be formal or elevated ⟨the first *couple* chapters are pretty good —E. B. White (letter)⟩ ⟨still operated a *couple* wagons for hire —Garrison Keillor⟩. It is most frequently used with periods of time ⟨a *couple* weeks⟩ and numbers ⟨a *couple* hundred⟩ ⟨a *couple* dozen⟩.

cou·ple·ment \ˈkə-pəl-mənt\ *n* [MF, fr. OF *cupler* to join, fr. L *copulare*, fr. *copula*] (1548) *archaic* : the act or result of coupling

cou·pler \ˈkə-p(ə-)lər\ *n* (1552) 1 : one that couples 2 : a contrivance on a keyboard instrument by which keyboards or keys are connected to play together

cou·plet \ˈkə-plət\ *n* [MF, dim. of OF *cuple*, *couple*] (1580) 1 : two successive lines of verse forming a unit marked usu. by rhythmic correspondence, rhyme, or the inclusion of a self-contained utterance : DISTICH 2 : COUPLE

cou·pling \ˈkə-pliŋ (*usual for 2*), -pə-liŋ\ *n* (14c) 1 : the act of bringing or coming together : PAIRING; *specif* : sexual union 2 : a device that serves to connect the ends of adjacent parts or objects 3 : the joining of or the part of the body that joins the hindquarters to the forequarters of a quadruped 4 : a means of electric connection of two electric circuits by having a part common to both

cou·pon \ˈkü-ˌpän, ˈkyü-\ *n* [F, fr. OF, piece, fr. *couper* to cut — more at COPE] (1822) 1 : a statement of due interest to be cut from a bearer bond when payable and presented for payment; *also* : the interest rate of a coupon 2 : a form surrendered in order to obtain an article, service, or accommodation: as a : one of a series of attached tickets or certificates often to be detached and presented as needed b : a ticket or form authorizing purchases of rationed commodities c : a certificate or similar evidence of a purchase redeemable in premiums d : a part of a printed advertisement to be cut off to use as an order blank or inquiry form or to obtain a discount on merchandise or services

that may be assembled or reassembled ⟨a bookcase in ~s⟩ **14 :** a division of an orchestra composed of one class of instruments ⟨the string ~⟩ **15 :** SIGNATURE 3b *syn* see PART

2**section** *vb* **sec·tioned; sec·tion·ing** \-sh(ə-)niŋ\ *vt* (1819) **1 :** to cut or separate into sections ⟨~ an orange⟩ **2 :** to represent in sections ~ *vi* **:** to become cut or separated into parts

1**sec·tion·al** \ˈsek-shnəl, -shə-nᵊl\ *adj* (1806) **1 a :** of or relating to a section **b :** local or regional rather than general in character ⟨~ interests⟩ **2 :** consisting of or divided into sections ⟨~ furniture⟩ — **sec·tion·al·ly** *adv*

2**sectional** *n* (1901) **:** a piece of furniture made up of modular units capable of use separately or in various combinations

sec·tion·al·ism \ˈsek-shnə-ˌli-zəm, -shə-nə-ˌli-\ *n* (1847) **:** an exaggerated devotion to the interests of a region

Section Eight *n* [*Section VIII*, Army Regulation 615–360, in effect from December 1922 to July 1944] (1943) **:** a discharge from the U.S. Army for military inaptitude or undesirable habits or traits of character; *also* **:** a soldier receiving such a discharge

section gang *n* (1889) **:** a crew of track workers employed to maintain a railroad section

section hand *n* (1873) **:** a laborer belonging to a section gang

1**sec·tor** \ˈsek-tər, -ˌtȯr\ *n* [LL, fr. L, cutter, fr. *secare* to cut — more at SAW] (1570) **1 a :** a geometric figure bounded by two radii and the included arc of a circle **b (1) :** a subdivision of a defensive military position **(2) :** a portion of a military front or area of operation **c :** an area or portion resembling a sector ⟨bilingual ~ of town —David Kleinberg⟩ **d :** a sociological, economic, or political subdivision of society ⟨cooperation between the public and private ~s —Peter Chapman⟩ **2 :** a mathematical instrument consisting of two rulers connected at one end by a joint and marked with several scales **3 :** a subdivision of a track on a computer disk — **sec·tor·al** \ˈsek-t(ə-)rəl\ *adj*

2**sec·tor** \-tər\ *vt* **sec·tored; sec·tor·ing** \-t(ə-)riŋ\ (1884) **:** to divide into or furnish with sectors

sec·to·ri·al \sek-ˈtȯr-ē-əl\ *adj* (1803) **:** of, relating to, or having the shape of a sector of a circle

1**sec·u·lar** \ˈse-kyə-lər\ *adj* [ME, fr. AF *seculer*, fr. LL *saecularis*, fr. *saeculum* the present world, fr. L, generation, age, century, world; akin to W *hoedl* lifetime] (14c) **1 a :** of or relating to the worldly or temporal ⟨~ concerns⟩ **b :** not overtly or specif. religious ⟨~ music⟩ **c :** not ecclesiastical or clerical ⟨~ courts⟩ ⟨~ landowners⟩ **2 :** not bound by monastic vows or rules; *specif* **:** of, relating to, or forming clergy not belonging to a religious order or congregation ⟨a ~ priest⟩ **3 a :** occurring once in an age or a century **b :** existing or continuing through ages or centuries **c :** of or relating to a long term of indefinite duration ⟨~ inflation⟩ — **sec·u·lar·i·ty** \ˌse-kyə-ˈla-rə-tē\ *n* — **sec·u·lar·ly** \ˈse-kyə-lər-lē\ *adv*

2**secular** *n, pl* **seculars** *or* **secular** (14c) **1 :** a secular ecclesiastic (as a diocesan priest) **2 :** LAYMAN

secular humanism *n* (1933) **:** HUMANISM 3; *esp* **:** humanistic philosophy viewed as a nontheistic religion antagonistic to traditional religion — **secular humanist** *n or adj*

sec·u·lar·ise *Brit var of* SECULARIZE

sec·u·lar·ism \ˈse-kyə-lə-ˌri-zəm\ *n* (1851) **:** indifference to or rejection or exclusion of religion and religious considerations — **sec·u·lar·ist** \-rist\ *n* — **secularist** *also* **sec·u·lar·is·tic** \ˌse-kyə-lə-ˈris-tik\ *adj*

sec·u·lar·ize \ˈse-kyə-lə-ˌrīz\ *vt* **-ized; -iz·ing** (1611) **1 :** to make secular **2 :** to transfer from ecclesiastical to civil or lay use, possession, or control **3 :** to convert to or imbue with secularism — **sec·u·lar·i·za·tion** \ˌse-kyə-lə-rə-ˈzā-shən\ *n* — **sec·u·lar·iz·er** *n*

1**se·cure** \si-ˈkyu̇r\ *adj* **se·cur·er; -est** [L *securus* safe, secure, fr. *se* without + *cura* care — more at SUICIDE] (ca. 1533) **1 a** *archaic* **:** unwisely free from fear or distrust **:** OVERCONFIDENT **b :** easy in mind **:** CONFIDENT **c :** assured in opinion or expectation **:** having no doubt **2 a :** free from danger **b :** free from risk of loss **c :** affording safety ⟨a ~ hideaway⟩ **d :** TRUSTWORTHY, DEPENDABLE ⟨a ~ foundation⟩ **3 :** ASSURED 1 ⟨a ~ victory⟩ — **se·cure·ly** *adv* — **se·cure·ness** *n*

2**secure** *vb* **se·cured; se·cur·ing** *vt* (1588) **1 a :** to relieve from exposure to danger **:** act to make safe against adverse contingencies ⟨~ a supply line from enemy raids⟩ **b :** to put beyond hazard of losing or of not receiving **:** GUARANTEE ⟨~ the blessings of liberty —*U.S. Constitution*⟩ **c :** to give pledge of payment to (a creditor) or of (an obligation) ⟨~ a note by a pledge of collateral⟩ **2 a :** to take (a person) into custody **:** hold fast **:** PINION **b :** to make fast ⟨~ a door⟩ ⟨~ a bike to a tree⟩ **3 a :** to get secure usu. lasting possession or control of ⟨~ a job⟩ **b :** BRING ABOUT, EFFECT **4 :** to release (naval personnel) from work or duty ~ *vi* **1** *of naval personnel* **:** to stop work **:** go off duty **2** *of a ship* **:** to tie up **:** BERTH *syn* see ENSURE — **se·cur·er** *n*

se·cure·ment \si-ˈkyu̇r-mənt\ *n* (1622) **1** *obs* **:** PROTECTION **2 :** the act or process of securing

se·cu·ri·tize \si-ˈkyu̇r-ə-ˌtīz\ *vt* **-tized; -tiz·ing** (1981) **:** to consolidate (as mortgage loans) and sell to other investors for resale to the public in the form of securities — **se·cu·ri·ti·za·tion** \-ˌkyu̇r-ə-tə-ˈzā-shən\ *n*

se·cu·ri·ty \si-ˈkyu̇r-ə-tē\ *n, pl* **-ties** (15c) **1 :** the quality or state of being secure: as **a :** freedom from danger **:** SAFETY **b :** freedom from fear or anxiety **c :** freedom from the prospect of being laid off ⟨job ~⟩ **2 a :** something given, deposited, or pledged to make certain the fulfillment of an obligation **b :** SURETY **3 :** an instrument of investment in the form of a document (as a stock certificate or bond) providing evidence of its ownership **4 a :** something that secures **:** PROTECTION **b (1) :** measures taken to guard against espionage or sabotage, crime, attack, or escape **(2) :** an organization or department whose task is security

security blanket *n* (1968) **1 :** a blanket carried by a child as a protection against anxiety **2 :** a usu. familiar object whose presence dispels anxiety

Security Council *n* (1944) **:** a permanent council of the United Nations with primary responsibility for maintaining peace and security

security interest *n* (1951) **:** the rights that a creditor has in the personal property of a debtor that secures an obligation **:** LIEN

security police *n* (1920) **1 :** police engaged in counterespionage **2 :** AIR POLICE

secy *abbr* secretary

sed *abbr* sedimentation

se·dan \si-ˈdan\ *n* [origin unknown] (1635) **1 :** a portable often covered chair that is designed to carry one person and that is borne on poles by two people **2 a :** a 2- or 4-door automobile seating four or more persons and usu. having a permanent top — compare COUPE **b :** a motorboat having one passenger compartment

1**se·date** \si-ˈdāt\ *adj* [L *sedatus*, fr. pp. of *sedare* to calm; akin to *sedēre* to sit — more at SIT] (1663) **:** keeping a quiet steady attitude or pace **:** UNRUFFLED *syn* see SERIOUS — **se·date·ly** *adv* — **se·date·ness** *n*

2**sedate** *vt* **se·dat·ed; se·dat·ing** [back-formation fr. *sedative*] (1945) **:** to dose with sedatives

se·da·tion \si-ˈdā-shən\ *n* (1543) **1 :** the inducing of a relaxed easy state esp. by the use of sedatives **2 :** a state resulting from or as if from sedation

1**sed·a·tive** \ˈse-də-tiv\ *adj* [ME, alleviating pain, fr. MF *sedatif*, fr. ML *sedativus*, fr. L *sedatus*] (1779) **:** tending to calm, moderate, or tranquilize nervousness or excitement

2**sedative** *n* (1797) **:** a sedative agent or drug

sed·en·tary \ˈse-dᵊn-ˌter-ē\ *adj* [MF *sedentaire*, fr. L *sedentarius*, fr. *sedent-, sedens*, prp. of *sedēre* to sit — more at SIT] (1598) **1 :** not migratory **:** SETTLED ⟨~ birds⟩ ⟨~ civilizations⟩ **2 a :** doing or requiring much sitting ⟨a ~ job⟩ **b :** not physically active ⟨a ~ lifestyle⟩ **3 :** permanently attached ⟨~ barnacles⟩

se·der \ˈsā-dər\ *n, pl* **seders** *also* **se·da·rim** \sə-ˈdär-əm, ˌse-dä-ˈrēm\ *often cap* [Heb *sēdher* order] (1865) **:** a Jewish home or community service including a ceremonial dinner held on the first or first and second evenings of the Passover in commemoration of the exodus from Egypt

se·de·runt \sə-ˈdir-ənt, -ˈder-\ *n* [L, there (they) sat (fr. *sedēre* to sit), word used to introduce list of those attending a session — more at SIT] (1825) **:** a prolonged sitting (as for discussion)

sedge \ˈsej\ *n* [ME *segge*, fr. OE *secg*; akin to MHG *segge* sedge, OE *sagu* saw — more at SAW] (bef. 12c) **:** any of a family (Cyperaceae, the sedge family) of usu. tufted monocotyledonous marsh plants differing from the related grasses in having achenes and solid stems; *esp* **:** any of a cosmopolitan genus (*Carex*) — **sedgy** \ˈse-jē\ *adj*

se·di·lia \sə-ˈdēl-yə, -ˈdil-, *esp Brit* -ˈdī-(ə-)lē-\ *n pl* [L, pl. of *sedile* seat, fr. *sedēre*] (1793) **:** seats on the south side of the chancel for the celebrant and his assistants

1**sed·i·ment** \ˈse-də-mənt\ *n* [L *sedimentum* settling, fr. *sedēre* to sit, sink down] (1547) **1 :** the matter that settles to the bottom of a liquid **2 :** material deposited by water, wind, or glaciers

2**sed·i·ment** \-ˌment\ *vt* (1859) **:** to deposit as sediment ~ *vi* **1 :** to settle to the bottom in a liquid **2 :** to deposit sediment

sed·i·ment·able \ˌse-də-ˈmen-tə-bəl\ *adj* (1943) **:** capable of being sedimented by centrifugation ⟨~ ribosomal particles⟩

sed·i·men·ta·ry \ˌse-də-ˈmen-tə-rē, -ˈmen-trē\ *adj* (1830) **1 :** of, relating to, or containing sediment ⟨~ deposits⟩ **2 :** formed by or from deposits of sediment ⟨~ rock⟩

sed·i·men·ta·tion \ˌse-də-mən-ˈtā-shən, -ˌmen-\ *n* (1848) **:** the action or process of forming or depositing sediment **:** SETTLING

sed·i·men·tol·o·gy \ˌse-də-mən-ˈtä-lə-jē, -ˌmen-\ *n* (1932) **:** a branch of science that deals with sedimentary rocks and their inclusions — **sed·i·men·to·log·ic** \-ˌmen-tə-ˈlä-jik\ *or* **sed·i·men·to·log·i·cal** \-ji-kəl\ *adj* — **sed·i·men·to·log·i·cal·ly** \-ji-k(ə-)lē\ *adv* — **sed·i·men·tol·o·gist** \-mən-ˈtä-lə-jist, -ˌmen-\ *n*

se·di·tion \si-ˈdi-shən\ *n* [ME *sedicioun*, fr. AF *sedicium*, fr. L *sedition-, seditio*, lit., separation, fr. *sed-*, *se-* apart + *ition-*, *itio* act of going, fr. *ire* to go — more at SECEDE, ISSUE] (14c) **:** incitement of resistance to or insurrection against lawful authority

se·di·tious \si-ˈdi-shəs\ *adj* (15c) **1 :** disposed to arouse or take part in or guilty of sedition **2 :** of, relating to, or tending toward sedition — **se·di·tious·ly** *adv* — **se·di·tious·ness** *n*

se·duce \si-ˈdüs, -ˈdyüs\ *vt* **se·duced; se·duc·ing** [LL *seducere*, fr. L, to lead away, fr. *se-* apart + *ducere* to lead — more at TOW] (15c) **1 :** to persuade to disobedience or disloyalty **2 :** to lead astray usu. by persuasion or false promises **3 :** to carry out the physical seduction of **:** entice to sexual intercourse **4 :** ATTRACT *syn* see LURE — **se·duc·er** *n*

se·duce·ment \-mənt\ *n* (1586) **1 :** SEDUCTION **2 :** something that serves to seduce

se·duc·tion \si-ˈdək-shən\ *n* [MF, fr. LL *seduction-*, *seductio*, fr. L, act of leading aside, fr. *seducere*] (1526) **1 :** the act of seducing; *esp* **:** the enticement of a person to sexual intercourse **2 :** something that seduces **:** TEMPTATION **3 :** something that attracts or charms

se·duc·tive \-ˈdək-tiv\ *adj* (1651) **:** tending to seduce **:** having alluring or tempting qualities ⟨a ~, sometimes disingenuous man —Thatcher Freund⟩ ⟨a ~ aroma⟩ — **se·duc·tive·ly** *adv* — **se·duc·tive·ness** *n*

se·duc·tress \-ˈdək-trəs\ *n* [obs. *seductor* male seducer, fr. LL, fr. *seducere* to seduce] (1802) **:** a woman who seduces

se·du·li·ty \si-ˈdü-lə-tē, -ˈdyü-\ *n* (1542) **:** sedulous activity **:** DILIGENCE

sed·u·lous \ˈse-jə-ləs\ *adj* [L *sedulus*, fr. *sedulo* sincerely, diligently, fr. *sed-*, *se* without + *dolus* guile — more at SUICIDE] (1540) **1 :** involving or accomplished with careful perseverance ⟨~ craftsmanship⟩ **2 :** diligent in application or pursuit ⟨a ~ student⟩ *syn* see BUSY — **sed·u·lous·ly** *adv* — **sed·u·lous·ness** *n*

se·dum \ˈsē-dəm\ *n* [NL, fr. L, houseleek] (1760) **:** any of a genus (*Sedum*) of widely distributed fleshy herbs of the orpine family — compare STONECROP

1**see** \ˈsē\ *vb* **saw** \ˈsȯ\; **seen** \ˈsēn\; **see·ing** \ˈsē-iŋ\ [ME *seen*, fr. OE *sēon*; akin to OHG *sehan* to see and perh. to L *sequi* to follow — more at SUE] *vt* (bef. 12c) **1 a :** to perceive by the eye **b :** to perceive or detect as if by sight **2 a :** to have experience of **:** UNDERGO ⟨~ army service⟩ **b :** to come to know **:** DISCOVER **c :** to be the setting or time of ⟨the last fifty years have *seen* a sweeping revolution in science —Barry Commoner⟩ **3 a :** to form a mental picture of **:** VISUALIZE ⟨can still ~ her as she was years ago⟩ **b :** to perceive the meaning or importance of **:** UNDERSTAND **c :** to be aware of **:** RECOGNIZE ⟨~s only our faults⟩ **d :** to imagine as a possibility **:** SUPPOSE ⟨couldn't ~

Exhibit C

Webster's American English Dictionary

NEW EDITION

- Over 40,000 clear, concise definitions
- Pronunciations and variant spellings

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count•less \-ləs\ *adj* : too many to be numbered

coun•try \ˈkəntrē\ *n, pl* **-tries 1** : nation **2** : rural area ∼ *adj* : rural — **coun•try•man** \-mən\ *n*

coun•try•side *n* : rural area or its people

coun•ty \ˈkau̇ntē\ *n, pl* **-ties** : local government division esp. of a state

coup \ˈkü\ *n, pl* **coups** \ˈküz\ **1** : brilliant sudden action or plan **2** : sudden overthrow of a government

coupe \ˈküp\ *n* : 2-door automobile with an enclosed body

cou•ple \ˈkəpəl\ *vb* **-pled; -pling** : link together ∼ *n* **1** : pair **2** : two persons closely associated or married

cou•pling \ˈkəpliŋ\ *n* : connecting device

cou•pon \ˈküˌpän, ˈkyü-\ *n* : certificate redeemable for goods or a cash discount

cour•age \ˈkərij\ *n* : ability to conquer fear or despair — **cou•ra•geous** \kəˈrājəs\ *adj*

cou•ri•er \ˈku̇rēər, ˈkərē-\ *n* : messenger

course \ˈkōrs\ *n* **1** : progress **2** : ground over which something moves **3** : part of a meal served at one time **4** : method of procedure **5** : subject taught in a series of classes ∼ *vb* **coursed; cours•ing 1** : hunt with dogs **2** : run speedily — **of course** : as might be expected

court \ˈkōrt\ *n* **1** : residence of a sovereign **2** : sovereign and his or her officials and advisers **3** : area enclosed by a building **4** : space marked for playing a game **5** : place where justice is administered ∼ *vb* : woo — **court•house** *n* — **court•room** *n* — **court•ship** \-ˌship\ *n*

cour•te•ous \ˈkərtēəs\ *adj* : showing politeness and respect for others — **cour•te•ous•ly** *adv*

cour•te•san \ˈkōrtəzən, ˈkərt-\ *n* : prostitute

cour•te•sy \ˈkərtəsē\ n, pl -sies : courteous behavior

court•ier \ˈkōrtēər, ˈkōrtyər\ *n* : person in attendance at a royal court

court•ly \ˈkōrtlē\ *adj* **-li•er; -est** : polite or elegant — **court•li•ness** *n*

court–mar•tial *n, pl* **courts–martial** : military trial court — **court–martial** *vb*

court•yard *n* : enclosure open to the sky that is attached to a house

cous•in \ˈkəzᵊn\ *n* : child of one's uncle or aunt

cove \ˈkōv\ *n* : sheltered inlet or bay

co•ven \ˈkəvən\ *n* : group of witches

cov•e•nant \ˈkəvənənt\ *n* : binding agreement — **cov•e•nant** \-nənt, -ˌnant\ *vb*

cov•er \ˈkəvər\ *vb* **1** : place something over or upon **2** : protect or hide **3** : include or deal with ∼ *n* : something that covers — **cov•er•age** \-ərij\ *n*

cov•er•let \-lət\ *n* : bedspread

co•vert \ˈkōˌvərt, ˈkəvərt\ *adj* : secret ∼ \ˈkəvərt, ˈkō-\ *n* : thicket that shelters animals

cov•et \ˈkəvət\ *vb* : desire enviously — **cov•et•ous** *adj*

cov•ey \ˈkəvē\ *n, pl* **-eys 1** : bird with her young **2** : small flock (as of quail)

[1]**cow** \ˈkau̇\ *n* : large adult female animal (as of cattle) — **cow•hide** *n*

[2]**cow** *vb* : intimidate

cow•ard \ˈkau̇ərd\ *n* : one who lacks courage — **cow•ard•ice** \-əs\ *n* — **cow•ard•ly** *adv or adj*

cow•boy *n* : a mounted ranch hand who tends cattle

cow•er \ˈkau̇ər\ *vb* : shrink from fear or cold

cow•girl *n* : woman ranch hand who tends cattle

cowl \ˈkau̇l\ *n* : monk's hood

cow•lick \ˈkau̇ˌlik\ *n* : turned-up tuft of hair that resists control

cow•slip \-ˌslip\ *n* : yellow flower

cox•swain \ˈkäkən, -ˌswān\ *n* : person who steers a boat

coy \ˈkȯi\ *adj* : shy or pretending shyness

coy•ote \ˈkīˌōt, kīˈōtē\ *n, pl* **coy•otes** *or* **coyote** : small No. American wolf

coz•en \ˈkəzᵊn\ *vb* : cheat

co•zy \ˈkōzē\ *adj* **-zi•er; -est** : snug

crab \ˈkrab\ *n* : short broad shellfish with pincers

crab•by \ˈkrabē\ *adj* **-bi•er; -est** : cross

[1]**crack** \ˈkrak\ *vb* **1** : break with a sharp sound **2** : fail in tone **3** : break without completely separating ∼ *n* **1** : sudden sharp noise **2** : witty remark **3** : narrow break **4** : sharp blow **5** : try

[2]**crack** *adj* : extremely proficient

crack•down *n* : disciplinary action — **crack down** *vb*

: kept from general knowledge — **se•cre•cy** \-krəsē\ *n* — **secret** *n* — **se•cre•tive** \ˈsēkrətiv, siˈkrēt-\ *adj* — **se•cret•ly** *adv*

sec•re•tar•i•at \ˌsekrəˈterēət\ *n* : administrative department

sec•re•tary \ˈsekrəˌterē\ *n, pl* **-tar•ies** **1** : one hired to handle correspondence and other tasks for a superior **2** : official in charge of correspondence or records **3** : head of a government department — **sec•re•tari•al** \ˌsekrəˈterēəl\ *adj*

¹se•crete \siˈkrēt\ *vb* **-cret•ed; -cret•ing** : produce as a secretion

²se•crete \siˈkrēt, ˈsēkrət\ *vb* **-cret•ed; -cret•ing** : hide

se•cre•tion \siˈkrēshən\ *n* **1** : process of secreting **2** : product of glandular activity

sect \ˈsekt\ *n* : religious group

sec•tar•i•an \sekˈterēən\ *adj* **1** : relating to a sect **2** : limited in character or scope ∼ *n* : member of a sect

sec•tion \ˈsekshən\ *n* : distinct part — **sec•tion•al** \-shənəl\ *adj*

sec•tor \ˈsektər\ *n* **1** : part of a circle between 2 radii **2** : distinctive part

sec•u•lar \ˈsekyələr\ *adj* **1** : not sacred **2** : not monastic

se•cure \siˈkyůr\ *adj* **-cur•er; -est** : free from danger or loss ∼ *vb* **1** : fasten safely **2** : get — **se•cure•ly** *adv*

se•cu•ri•ty \siˈkyůrətē\ *n, pl* **-ties** **1** : safety **2** : something given to guarantee payment **3** *pl* : bond or stock certificates

se•dan \siˈdan\ *n* **1** : chair carried by 2 men **2** : enclosed automobile

¹se•date \siˈdāt\ *adj* : quiet and dignified — **se•date•ly** *adv*

²sedate *vb* **-dat•ed; -dat•ing** : dose with sedatives — **se•da•tion** \siˈdāshən\ *n*

sed•a•tive \ˈsedətiv\ *adj* : serving to relieve tension ∼ *n* : sedative drug

sed•en•tary \ˈsedᵊnˌterē\ *adj* : characterized by much sitting

sedge \ˈsej\ *n* : grasslike marsh plant

sed•i•ment \ˈsedəmənt\ *n* : material that settles to the bottom of a liquid or is deposited by water or a glacier — **sed•i•men•ta•ry** \ˌsedəˈmentərē\ *adj* — **sed•i•men•ta•tion** \-mənˈtāshən, -ˌmen-\ *n*

se•di•tion \siˈdishən\ *n* : revolution against a government — **se•di•tious** \-əs\ *adj*

se•duce \siˈdüs, -ˈdyüs\ *vb* **-duced; -duc•ing** **1** : lead astray **2** : entice to sexual intercourse — **se•duc•er** *n* — **se•duc•tion** \-ˈdəkshən\ *n* — **se•duc•tive** \-tiv\ *adj*

sed•u•lous \ˈsejələs\ *adj* : diligent

¹see \ˈsē\ *vb* **saw** \ˈsȯ\; **seen** \ˈsēn\; **see•ing** **1** : perceive by the eye **2** : have experience of **3** : understand **4** : make sure **5** : meet with or escort

²see *n* : jurisdiction of a bishop

seed \ˈsēd\ *n, pl* **seed** *or* **seeds** **1** : part by which a plant is propagated **2** : source ∼ *vb* **1** : sow **2** : remove seeds from — **seed•less** *adj*

seed•ling \-liŋ\ *n* : young plant grown from seed

seedy \-ē\ *adj* **seed•i•er; -est** **1** : full of seeds **2** : shabby

seek \ˈsēk\ *vb* **sought** \ˈsȯt\; **seek•ing** **1** : search for **2** : try to reach or obtain — **seek•er** *n*

seem \ˈsēm\ *vb* : give the impression of being — **seem•ing•ly** *adv*

seem•ly \-lē\ *adj* **seem•li•er; -est** : proper or fit

seep \ˈsēp\ *vb* : leak through fine pores or cracks — **seep•age** \ˈsēpij\ *n*

seer \ˈsēər\ *n* : one who foresees or predicts events

seer•suck•er \ˈsirˌsəkər\ *n* : light puckered fabric

see•saw \ˈsēˌsȯ\ *n* : board balanced in the middle — **seesaw** *vb*

seethe \ˈsēth\ *vb* **seethed; seeth•ing** : become violently agitated

seg•ment \ˈsegmənt\ *n* : division of a thing — **seg•ment•ed** \-ˌmentəd\ *adj*

seg•re•gate \ˈsegriˌgāt\ *vb* **-gat•ed; -gat•ing** **1** : cut off from others **2** : separate by races — **seg•re•ga•tion** \ˌsegriˈgāshən\ *n*

seine \ˈsān\ *n* : large weighted fishing net ∼ *vb* : fish with a seine

seis•mic \ˈsīzmik, ˈsīs-\ *adj* : relating to an earthquake

seis•mo•graph \-məˌgraf\ *n* : apparatus for detecting earthquakes

seize \ˈsēz\ *vb* **seized; seiz•ing** : take by force — **sei•zure** \ˈsēzhər\ *n*

sel•dom \ˈseldəm\ *adv* : not often

se•lect \səˈlekt\ *adj* **1** : favored **2** : discriminating ∼ *vb* : take by preference — **se•lec•tive** \-ˈlektiv\ *adj*

se•lec•tion \səˈlekshən\ *n* : act of selecting or thing selected

se•lect•man \siˈlektˌman, -mən\ *n* : New England town official

Exhibit D

Designation: F 412 – 09

An American National Standard

Standard Terminology Relating to Plastic Piping Systems[1]

This standard is issued under the fixed designation F 412; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This terminology is a compilation of definitions of technical terms used in the plastic piping industry. Terms that are generally understood or adequately defined in other readily available sources are not included.

1.2 When a term is used in an ASTM document for which Committee F17 is responsible it is included only when judged, after review, by Subcommittee F17.91 to be a generally usable term.

1.3 Definitions that are identical to those published by other ASTM committees or other standards organizations are identified with the committee number (for example, D20) or with the abbreviation of the name of the organization (for example, IUPAC International Union of Pure and Applied Chemistry).

1.4 A definition is a single sentence with additional information included in notes.

1.5 Definitions are followed by the committee responsible for the standard(s) (for example, [F17.26]) and standard numbers(s) in which they are used (for example, F 714).

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C 114 Test Methods for Chemical Analysis of Hydraulic Cement
D 256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
D 638 Test Method for Tensile Properties of Plastics
D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
D 747 Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D 882 Test Method for Tensile Properties of Thin Plastic Sheeting
D 883 Terminology Relating to Plastics
D 907 Terminology of Adhesives
D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics
D 1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
D 1488 Test Method for Amylaceous Matter in Adhesives
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1527 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
D 1785 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
D 2104 Specification for Polyethylene (PE) Plastic Pipe, Schedule 40
D 2239 Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
D 2241 Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
D 2282 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe[3]
D 2444 Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
D 2447 Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
D 2513 Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
D 2661 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
D 2666 Specification for Polybutylene (PB) Plastic Tubing[3]
D 2680 Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
D 2683 Specification for Socket-Type Polyethylene Fittings

[1] This terminology is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.91 on Editorial and Terminology.

Current edition approved May 1, 2009. Published June 2009. Originally approved in 1975. Last previous edition approved in 2007 as F 412 – 07.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

for Outside Diameter-Controlled Polyethylene Pipe and Tubing
D 2737 Specification for Polyethylene (PE) Plastic Tubing
D 2751 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
D 2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
D 2846/D 2846M Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
D 3035 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
D 3139 Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
D 3261 Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
D 3309 Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems
D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
F 402 Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
F 405 Specification for Corrugated Polyethylene (PE) Pipe and Fittings
F 441/F 441M Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
F 442/F 442M Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR–PR)
F 449 Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control
F 628 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core
F 645 Guide for Selection, Design, and Installation of Thermoplastic Water- Pressure Piping Systems
F 714 Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
F 771 Specification for Polyethylene (PE) Thermoplastic High-Pressure Irrigation Pipeline Systems
F 876 Specification for Crosslinked Polyethylene (PEX) Tubing
F 877 Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems
F 891 Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core
F 948 Test Method for Time-to-Failure of Plastic Piping Systems and Components Under Constant Internal Pressure With Flow
F 1025 Guide for Selection and Use of Full-Encirclement-Type Band Clamps for Reinforcement or Repair of Punctures or Holes in Polyethylene Gas Pressure Pipe
F 1335 Specification for Pressure-Rated Composite Pipe and Fittings for Elevated Temperature Service
F 1473 Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins
F 1488 Specification for Coextruded Composite Pipe
F 1499 Specification for Coextruded Composite Drain, Waste, and Vent Pipe (DWV)
F 1668 Guide for Construction Procedures for Buried Plastic Pipe
F 1733 Specification for Butt Heat Fusion Polyamide(PA) Plastic Fitting for Polyamide(PA) Plastic Pipe and Tubing
F 1760 Specification for Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
F 1924 Specification for Plastic Mechanical Fittings for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing
F 1948 Specification for Metallic Mechanical Fittings for Use on Outside Diameter Controlled Thermoplastic Gas Distribution Pipe and Tubing
F 1970 Specification for Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems
F 1973 Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems
F 1986 Specification for Multilayer Pipe Type 2, Compression Fittings, and Compression Joints for Hot and Cold Drinking-Water Systems
F 1987 Specification for Multilayer Pipe Type 2, Compression Fittings, and Compression Joints for Hydronic Heating Systems
F 2145 Specification for Polyamide 11 (PA 11) and Polyamide 12 (PA12) Mechanical Fittings for Use on Outside Diameter Controlled Polyamide 11 and Polyamide 12 Pipe and Tubing
F 2158 Specification for Residential Central-Vacuum Tube and Fittings
F 2160 Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)
F 2176 Specification for Mechanical Couplings Used on Polyethylene Conduit, Duct and Innerduct

2.2 *ISO Standards:*[4]
ISO 3 Preferred Numbers
ISO 497 Preferred Numbers
ISO R 161 Pipes of Plastics Materials for the Transport of Fluids (Outside Diameters and Nominal Pressures) Part I, Metric Series
ISO TR 9080 Thermolplastics Pipes for the Transport of Fluids-Methods of Extrapolation of Hydrostatic Stress Rupture Data to Determine the Long-Term Hydrostatic Strength of Thermoplastic Pipe Materials

2.3 *ANSI Standard:*[4]

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

Z17.1 ANSI Preferred Numbers
2.4 *PPI Standard:*[5]
PPI TR-4

3. Terminology

acceptance testing—testing performed on a product to determine whether or not an individual lot of the product conforms with specified requirements. **[F17]**

DISCUSSION—The number of requirements are usually fewer than for **qualification testing** (see definition).

acetal plastics, *n*—highly crystalline linear thermoplastic homopolymers or copolymers characterized by repeating oxymethylene units. **[F17]**

acrylonitrile-butadiene-styrene (ABS) pipe and fitting plastics—plastics containing polymers or blends of polymers, or both, in which the minimum butadiene content is 6%, the minimum acrylonitrile content is 15 %, the minimum styrene or substituted styrene content, or both, is 15 %, and the maximum content of all other monomers is not more than 5 %; plus lubricants, stabilizers, and colorants. **[F17.61] D 1527, D 2282 [17.62] D 2680, D 2751**

adhesive—a substance capable of holding materials together by surface attachment. **[F17]**

adhesive bonded joint—see **joint, adhesive bonded**.

adhesive, solvent—see **solvent cement**.

adiabatic extrusion—a method of extrusion in which, after the extrusion apparatus has been heated sufficiently by conventional means to plastify the material, the extrusion process can be continued with the sole source of heat being the conversion of the drive energy, through viscous resistance of the plastic mass in the extruder. **[D20] D 883**

aging, *n*—(*1*) the effect on materials of exposure to an environment for an interval of time.

(*2*) the process of exposing materials to an environment for an interval of time. **[D20] D 883**

alloy, *n—in plastics,* two or more immiscible polymers united, usually by another component, to form a plastic resin having enhanced performance properties. **[D20] D 883**

antioxidant, *n*—compounding ingredient used to retard deterioration caused by oxidation. **[F17]**

apparent density—the weight per unit volume of a material including voids inherent in the material as tested. **[F17]**

DISCUSSION—The term bulk density is commonly used for material such as molding powder.

approving authority—the individual official, board, department, or agency established and authorized by a state, county, city, or other political subdivision, created by law to administer and enforce specified requirements.

artificial weathering—exposure to laboratory conditions, which may be cyclic, involving temperature, relative humidity, radiant energy, or any other conditions or pollutants found in the atmosphere in various geographical areas; or both. **[F17]**

DISCUSSION—The interlaboratory exposure conditions are usually intensified beyond those encountered in actual outdoor exposure in an attempt to achieve an accelerated effect.

backfill—all material used to fill the trench from bedding to finished surface. **[F17.65] F 449, F 1668**

backfill, final—material used to fill the trench from initial backfill to finished surface. **[F17]**

backfill, initial—material used to fill the trench from top of bedding to a designated height over the pipe. **[F17]**

backfill, pipe zone—see **pipe zone backfill**.

backfill, unconsolidated—noncompacted material in place in trench. **[F17]**

beam loading—the application of a load to a pipe between two points of support, usually expressed in newtons (or pounds-force) and the distance between the centers of the supports. **[F17]**

bedding, *n*—materials placed in the bottom of the trench on top of the foundation soil which provides stable bottom support for buried pipe including the trench bottom groove support angle or select material placed around the pipe, and envelope or filter materials where used during insulation. **[F17.65] F 449, F 1668**

bedding, *v*—placement of support materials for buried pipe. **[F17]**

bell-and-spigot joint—see **joint, bell-and-spigot gasket.**

bell end—the enlarged portion of a pipe that resembles the socket portion of a fitting and that is intended to be used to make a joint. **[F17]**

bend—a fitting either molded separately or formed from pipe for the purpose of accommodating a directional change. **[F17]**

DISCUSSION—Also called *ell*, *elbow*, or *sweep.* Bends generally imply fittings of relatively shorter radii than sweeps.

beveled pipe—a pipe with an end chamfered to mate or adjust to another surface or to assist in assembly. **[F17]**

binder, *n*—in a reinforced plastic, the continuous phase which holds together the reinforcement. **[D20] D 883**

DISCUSSION—During fabrication, the binder, which may be either thermoplastic or thermoset, usually undergoes a change in state.

blinding—the placement of soil, bedding material over and on the sides of the pipe, tubing or envelope to ensure proper grade, alignment, support, and protection of pipe during backfilling and after installation. **[F17.65] F 449**

blister, *n*—an imperfection, a rounded elevation of the surface of a plastic, with boundaries that may be more or less sharply defined, somewhat resembling in shape a blister on the human skin. **[D20] D 883**

bloom, *n*—a visible exudation or efflorescence on the surface of a material. **[D20] D 883**

blow molding—a method of fabrication in which a heated parison (hollow tube) is forced into the shape of a mold cavity by internal gas pressure. **[D20] D 883**

blowing agent—a compounding ingredient used to produce gas by chemical or thermal action, or both, in manufacture of hollow or cellular articles. **[D20] D 883**

[5] Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, http://www.plasticpipe.org.

brittle failure—a pipe failure mode which exhibits no visible (to the naked eye) permanent material deformation (stretching, elongation, or necking down) in the area of the break. **[F17.40] F 1473**

building drain—that part of the lowest horizontal piping of a drainage system that receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer beyond the foundation walls of the building or structure. **[F17]**

Discussion—The building sewer generally begins 2 to 5 ft beyond the foundation walls.

building drain (sanitary)—a building drain that conveys gray water or sewage, or both. **[F17]**

building drain (storm)—a building drain that conveys storm water only. **[F17]**

building sanitary sewer—that part of the horizontal piping of a sanitary drainage system which extends from the building sanitary drain, receives the discharge of the building sanitary drain, and conveys it to a public sewer, private sewer, individual sewage disposal system, or other point of disposal. **[F17]**

building storm sewer—that part of the horizontal piping of a storm drainage system which extends from the building storm drain, receives the discharge of the building storm drain, and conveys it to a public storm sewer, private storm sewer, or other point of disposal. **[F17]**

building supply—See **water service.**

bulk factor, *n*—the ratio of the volume of a given mass of molding material to its volume in the molded form. **ISO/ [D20] D 883**

Discussion—The bulk factor is also equal to the ratio of the density of the material to its apparent density in the unmolded form.

burst strength—the internal pressure required to cause a pipe or fitting to fail. **[F17]**

Discussion—This pressure will vary with the rate of buildup of the pressure and the time during which the pressure is held.

butt-fused joint—see **joint, butt-fused.**

butylene plastics—plastics based on resins made by the polymerization of butene or copolymerization of butene with one or more unsaturated compounds, the butene being in greatest amount by weight. **[D20] D 883**

cell, *n*—a small cavity surrounded partially or completely by walls. **[D20] D 883**

cell, closed—a cell totally enclosed by its walls and hence not interconnecting with other cells. (See also **cell** and **cell, open**.) **ISO/[D20] D 883**

cell, open—a cell not totally enclosed by its walls and hence interconnecting with other cells. (See also **cell** and **cell, closed**.) **[D20] D 883**

cellular plastic—a plastic containing numerous cells, intentionally introduced, interconnecting or not, distributed throughout the mass. **[D20] D 883 [17.63] F 628 [17.25] F 891**

cellulose acetate butyrate (CAB) plastics—plastic made by compounding a cellulose acetate butyrate ester with plasticizers and other ingredients. Cellulose acetate butyrate ester is a derivative of cellulose (obtained from cotton or wool pulp, or both) made by converting some of the hydroxyl groups in cellulose to acetate and butyrate groups with chemicals. **[F17]**

central vacuum tubing, *n*—plastic tubing used for residental central vacuum systems in which outside diameter is controlled and where the wall thickness is usually small when compared to the diameter. **[F17.25] F 2158**

chalking, *n—in plastics*, a powdery residue on the surface of a material resulting from degradation or migration of an ingredient, or both. **[D20] D 883**

Discussion—Chalking may be a designed-in characteristic.

chemical cleaner—see **cleaner, chemical.**

chemical resistance—the ability to resist chemical attack. **[F17]**

Discussion—The attack is dependent on the method of test and its severity is measured by determining the changes in physical properties. Time, temperature, stress, and reagent may all be factors that affect the chemical resistance of a material.

chemically formed polymeric material—a cellular material in which the cells are formed by gases generated from thermal decomposition or other chemical reaction. **[D20] D 883**

chlorinated poly(vinyl chloride) plastics—plastics based on chlorinated poly(vinyl chloride) in which the chlorinated poly(vinyl chloride) is in the greatest amount by weight. **[D20] D 883**

chlorofluorocarbon plastics—plastics based on polymers made with monomers composed of chlorine, fluorine, and carbon only. **ISO/ [D20] D 883**

chlorofluorohydrocarbon plastics, *n*—plastics based on polymers made with monomers composed of chlorine, fluorine, hydrogen, and carbon only. **ISO/[D20] D 883**

cleaner, chemical—an organic solvent used to remove foreign matter from the surface of plastic pipe and fittings. **[F17.20] F 402**

Discussion—Cleaners have essentially no effect on the plastic surface being cleaned and may be used prior to joining with a solvent cement or adhesive.

cleaner, mechanical—an abrasive material or device used to remove foreign matter and gloss from the surface of plastic pipe and fittings. **[F17]**

Discussion—Mechanical cleaners may be used prior to joining with a solvent cement or adhesive.

closed-cell cellular plastics—cellular plastics in which almost all the cells are noninterconnecting. **[D20] D 883 [F17.63] F 628**

closed-cell foamed plastics—See **closed-cell cellular plastics.**

code—(*1*) a system of symbols, letters or numbers, used to convey a message requiring brevity; (*2*) a set of rules established by a legal or quasi-legal body. **[F17]**

code, classification—a code that identifies a plastic material by its properties in accordance with the pertinent ASTM specification. **[F17]**

code, manufacturer's—a code that provides manufacturing identity for a piping product. **[F17]**

code, thermoplastic pipe materials designation— letters and ciphers for the designation of stress-rated thermoplastic compound, which consists of two or three letters to indicate the abbreviation as listed in Terminology D 1600, for the type of thermoplastic resin—followed by four Arabic numerals—two to describe the short-term properties, in accordance with the ASTM standard being referenced, and two to designate the hydrostatic design stress when tested in water at 73°F (23°C) in units of 100 psi, with any decimal figures dropped. **[F17]**

DISCUSSION—In some ASTM standards, the short-term properties with more than two numbers have a table provided to convert to two numbers to be used in the code.

DISCUSSION—When the hydrostatic design stress code is less than two numbers, a zero is inserted before the number.

DISCUSSION—For polyethylene compound, the short-term properties are described using two Arabic numerals in accordance with Specification D 3350, specifically, the cell classification number value for density followed by the cell classification number value for slow crack growth resistance.

coextrusion—a process whereby two or more heated or unheated plastic material streams forced through one or more shaping orifice(s) become one continuously formed piece. **[F17.63] D 2661, F 628 [F17.25] F 891, F 1760 [F17.11] F 1488**

cold flow—See **creep.**

cold molding—a special process of compression molding in which the molding is formed at room temperature and subsequently baked at elevated temperatures. **[D20] D 883**

collapse, *n*—(*1*) inadvertent densification of cellular material during manufacture resulting from breakdown of cell structure; (*2*) the buckling of the inner liner of composite piping; (*3*) the buckling or flattening of a plastic rehabilitation liner; (*4*) the buckling or crushing of a plastic pipe from external forces, such as earth loads or external hydrostatic load. **[F17]**

compaction, soil—act of packing soil with mechanical force to increase its density. **[F17]**

compatible—(*1*) a condition wherein components of a plastic piping system or different specific plastic materials, or both, can be joined together for satisfactory joints. (*2*) in relation to elastomeric seal joints, a condition wherein the elastomer does not adversely affect the pertinent properties of the plastic pipe or fittings, or both, when the sealing gasket is in intimate contact with the plastic for a prolonged period. **[F17]**

composite pipe—pipe consisting of two or more different materials arranged with specific functional purpose to serve as pipe. **[F17]**

compound, *n*—a mixture of a polymer with other ingredients such as fillers, stabilizers, catalysts, processing aids, lubricants, modifiers, pigments, or curing agents. **[F17.11] F 1488, F 1499**

compression fitting joint—see **joint, compression fitting.**

compression gasket joint—see **joint, compression gasket.**

compression molding—the method of molding a material already in a confined cavity by applying pressure and usually heat. **[D20] D 883**

conduit, (duct), *n*—a tubular raceway for carrying electric wires, cables, or other conductors. **[F17.10] F 2176 [F17.26] F 2160**

consolidation—reduction in volume of soil as a result of gravitational forces. **[F17]**

contamination—the presence of a substance not intentionally incorporated in a product. **[F17]**

continuous waste—a drain connecting two or more plumbing fixtures or components of plumbing fixtures to a common trap. **[F17]**

crack—any narrow opening or fissure in the surface that is visible to the naked eye. **[F17.65] F 405**

crater, *n*—a small, shallow surface imperfection. **[D20] D 883**

crazing, *n*—apparent fine cracks at or under the surface of a plastic. **[D20] D 883**

DISCUSSION—The crazed areas are composed of polymeric material of lower density than the surrounding matrix.

creep, *n*—the time-dependent part of strain resulting from stress, that is dimensional change caused by the application of load over and above the elastic deformation and with respect to time. **[D20] D 883, [17.60] F 1025**

cross laminate—a laminate in which some of the layers of material are oriented approximately at right angles to the remaining layers with respect to the grain or strongest direction in tension. (See also **parallel laminate**.) **[D20] D 883**

crosslinking, *n*—the formation of a three dimensional polymer by means of interchain reactions resulting in changes in physical properties. **[D20] D 883**

cure, *v*—to change the properties of a polymeric system into a more stable, usable condition by the use of heat, radiation, or reaction with chemical additives. **ISO/[D20] D 883**

DISCUSSION—Cure may be accomplished, for example, by removal of solvent or by crosslinking.

deadload—the static load imposed on the top of the pipe. **[F17]**

deflection temperature—the temperature at which a specimen will deflect a given distance at a given load under prescribed conditions of test. (See Test Method D 648.) Formerly called heat distortion. **[F17]**

degradation, *n*—a deleterious change in chemical structure, physical properties, or appearance of a plastic. **[D20] D 883**

denisty, apparent—see **apparent density**.

density of plastics—the weight per unit volume of material at 23°C expressed as D23c, g/cm^3(kg/m^3). **[F17]**

DISCUSSION—Taken from Test Method D 1505.

depth, *n*—in the case of a beam, the dimension parallel to the direction in which the load is applied. **[D20] D 883**

diffusion—the movement of a material such as a gas or liquid, in the body of a plastic. **[F17]**

DISCUSSION—If the gas or liquid is absorbed on one side of a piece of plastic and given off on the other side, the phenomenon is called permeability. Diffusion and permeability are not due to holes or pores in the plastic.

dimension ratio (DR)—the average specified diameter of a

pipe or tubing divided by the minimum specified wall thickness. The DR values shall be rounded to the nearest 0.5 unless otherwise specified. **[F17.10] D 2683, D 3261, F 1733 [17.11] D 1488 [F17.26] D 2737, [F17.60] D 2513**

DISCUSSION—Each pipe can have two dimension ratios depending on whether the outside or inside diameter is used. In practice, the outside diameter is used if the standards requirement and manufacturing control are based on this diameter. The inside diameter is used when this measurement is the controlling one.

dry-blend, *n*—dry compound prepared without fluxing or addition of solvent (also called powder blend). **[D20] D 883**

ductile failure—a pipe failure mode which exhibits material deformation (stretching, elongation, or necking down) in the area of the break. **[F17]**

elastomer, *n*—a macromolecular material that at room temperature returns rapidly to approximately its initial dimensions and shape after substantial deformation by a weak stress and release of the stress. **[D20] D 883**

elastomeric seal—a material or device that uses an elastomer to effect a seal between separable piping components. **[F17]**

elevated temperature testing—tests on plastic pipe above 23°C (73°F). **[F17]**

embedment—the placement of materials completely around the pipe to provide support. **[F17.62] F 1668**

encasement, *n*—see **incasement,** *n.*

encasement, *v*—see **incasement,** *v.*

engineering plastics, *n*—those plastics and polymeric compositions for which well-defined properties are available, such that engineering rather than empirical methods can be used for design and manufacture of products requiring definite and predictable performance in structural applications over a substantial temperature range. **[D20] D 883**

envelope, drainage—the materials completely surrounding a pipe to provide support or protection or act as a filter. **[F17]**

environmental stress cracking—the development of cracks in a material that is subjected to stress or strain in the presence of specific chemicals. **[F17]**

ethylene plastics, *n*—plastics based on polymers of ethylene or copolymers of ethylene with other monomers, the ethylene being in greatest amount by mass. **ISO/[D20] D 883**

exfiltration, pipe—the passage of fluid from a pipe section through small holes or leaks. **[F17]**

expandable plastic, *n*—a plastic in a form capable of being made cellular by thermal, chemical, or mechanical means. **[D20] D 883**

expanded plastics—See **cellular plastics.**

extrusion, *n*—a process in which heated or unheated plastic is forced through a shaping orifice (a die) in one continuously formed shape as film, sheet, rod, or tubing. **[D20] D 883**

extrusion, adiabatic—see **adiabatic extrusion**.

fabricating, *n*—the manufacture of plastic products from molded parts, rods, tubes, sheeting, extrusions, or other forms by appropriate operations such as punching, cutting, drilling, and tapping including fastening plastic parts together or to other parts by mechanical devices, adhesives, heat sealing, or other means. **[D20] D 883**

failure, adhesive—rupture of an adhesive bond, such that the plane of separation appears to be at the adhesive-adherend interface. **[F17]**

failure, brittle—see **brittle failure**

failure, ductile—see **ductile failure**

failure, slit —see **silt failure**

filler, *n*—a relatively inert material added to a plastic to modify its strength, permanence, working properties, or other qualities or to lower costs. (See also **reinforced plastic**.) **[D20] D 883**

fish-eye, *n*—small globular mass that has not blended completely into the surrounding material. **[D20] D 883**

fitting, *n*—a piping component used to join or terminate sections of pipe or to provide changes of direction or branching in a pipe system. **[F17]**

flanged joint—see **joint, flanged.**

flare joint—see **joint, flare.**

flow rate—rate of extrusion, weight per unit of time, g/10 min (kg/s), of molten resins through a die of specified length and diameter, under prescribed conditions of temperature, load, and piston position in the barrel as the timed measurement is being made. **[F17]**

fluorocarbon plastic, *n*—a plastic based on polymers made with perfluoromonomers. **ISO/[D20] D 883**

DISCUSSION—When the monomer is essentially tetrafluoroethylene, the prefix TFE is sometimes used to designate these materials. It is preferable to use the accepted abbreviation, PFTE. TFE should not be used by itself to mean PTFE. When the resins are copolymers of tetrafluoroethylene and hexafluoropropylene, the resins may be designated with the prefix FEP. Other prefixes may be adopted to designate other fluorocarbon plastics.

fluorohydrocarbon plastics, *n*—plastics based on polymers made with monomers composed of fluorine, hydrogen, and carbon only. **ISO/[D20] D 883**

fluoroplastic, *n*—a plastic based on polymers made from monomers containing one or more atoms of fluorine, or copolymers of such monomers with other monomers, the fluorine-containing monomer(s) being in the greatest amount by mass. **[D20] D 883**

DISCUSSION—For specific examples of fluoroplastic see **fluorocarbon plastic, chlorofluorocarbon plastics, fluorohydrocarbon plastics, and chlorofluorohydrocarbon plastic.**

foamed plastics, *n*—See **cellular plastics** (the preferred terminology).

forming, *n*—a process in which the shape of plastic pieces such as sheets, rods, or tubes is changed to a desired configuration. **[D20] D 883**

DISCUSSION—The use of the term "forming" in plastics technology does not include such operations as molding, casting, or extrusion, in which shapes or pieces are made from molding materials or liquids.

frosting, *n*—a light-scattering surface resembling fine crystals. See also **chalking, haze, bloom**. **[F17]**

fungi resistance—the ability of plastic pipe to withstand fungi growth or their metabolic products, or both, under normal conditions of service or laboratory tests simulating such conditions. **[F17]**

fuse, *v*—(*1*) to convert plastic powder or pellets into a homogeneous mass through heat and pressure; (*2*) to make a plastic piping joint by heat and pressure. **[F17]**

gasket joint—see **joint, compression gasket** and **joint, bell-and-spigot gasket.**

gate, *n*—in an injection mold, a constriction in the flow channel between the runner and the mold cavity. **[D20] D 883**

gel, *n*—(*1*) a semisolid system consisting of a network of solid aggregates in which liquid is held; (*2*) the initial jelly-like solid phase that develops during the formation of a resin from a liquid; (*3*) with respect to vinyl plastisols, gel is a state between liquid and solid that occurs in the initial stages of heating, or upon prolonged storage. **[D20] D 883**

DISCUSSION—All three types of gel have very low strengths and do not flow like a liquid. They are soft, flexible, and may rupture under their own weight unless supported externally.

gel point—the stage at which a liquid begins to exhibit pseudo-elastic properties. **[D20] D 883**

DISCUSSION—This stage may be conveniently observed from the inflection point on a viscosity-time plot. (See **gel** (*2*).)

gel time, *n*—the period of time from the initial mixing of the reactants of a liquid material composition to the time when gelation occurs, as defined by a specific test method. **[D20] D 883**

DISCUSSION—For a material that must be processed by exposure to some form of energy, the zero time is the start of exposure.

glass transition—the reversible change in an amorphous polymer or in amorphous regions of a partially crystalline polymer from (or to) a viscous or rubbery condition to (or from) a hard and relatively brittle one. **[D20] D 883**

DISCUSSION—The glass transition generally occurs over a relatively narrow temperature region and is similar to the solidification of a liquid to a glassy state; it is not a phase transition. Not only do hardness and brittleness undergo rapid changes in this temperature region but other properties, such as thermal expansibility and specific heat also change rapidly. This phenomenon has been called second order transition, rubber transition, and rubbery transition. The word transformation has also been used instead of transition. Where more than one amorphous transition occurs in a polymer, the one associated with segmental motions of the polymer backbone chain or accompanied by the largest change in properties is usually considered to be the glass transition.

glass transition temperature (Tg)—the approximate mid-point of the temperature range over which the glass transition takes place. **[D20] D 883**

DISCUSSION—The glass transition temperature can be determined readily only by observing the temperature at which a significant change takes place in a specific electrical, mechanical, or other physical property. Moreover, the observed temperature can vary significantly depending on the specific property chosen for observation and on details of the experimental technique (for example, rate of heating, frequency). Therefore, the observed Tg should be considered only an estimate. The most reliable estimates are normally obtained from the loss peak observed in dynamic mechanical tests or from dialatometric data.

graft copolymer—a copolymer in which polymeric side chains have been attached to the main chain of a polymer of different structure. **[D20] D 883**

gravity flow, *n*—liquefied medium conveyance that is induced by a positive elevation head such as a downward pipeline slope or a higher elevation reservoir. **[F17]**

gravity flow, non-pressure, *n*—gravity flow of liquefied medium in a piping system that is not pressure-rated and where flow is regularly less than full (open channel flow) except during conditions when the system may become temporarily surcharged in which case, the system is subject to temporary internal hydrostatic pressure that is generally limited to piping system joint capabilities.[F17]

gravity flow, pressure, *n*—gravity flow of liquefied medium in a pressure-rated piping system where flow regularly fills the piping system (closed channel flow) and subjects the piping system to internal hydrostatic pressure that is within the capabilities of pressure-rated piping system components and joints. **[F17]**

gray water—the waste water of a system that may be a combination of the liquid and water-carried wastes except human wastes. **[F17]**

groove angle—the angle of support for a pipe when a formed groove is made in bedding or foundation. **[F17]**

gusset, *n*—(*1*) a piece used to give additional size or strength in a particular location of an object.

(*2*) the folded-in portion of flattened tubular film. **[D20] D 883**

haunching—the act of placing bedding material around the haunch of the pipe. **[F17]**

haunch—that portion of the pipe barrel extending from bottom to springline. **[F17]**

haze—the cloudy or turbid aspect or appearance of an otherwise transparent specimen caused by light scattered from within the specimen or from its surfaces. **[D20] D 883**

DISCUSSION—For the purpose of Test Method D 1003, haze is the percentage of transmitted light which, in passing through the specimen, deviates from the incident beam through forward scatter more than 2.5° on the average.

heat-fused joint—see **joint, heat-fused.**

heat joining—making a joint by heating the mating surfaces of the pipe components to be joined and pressing them together so that they fuse and become essentially one piece. **[F17]**

DISCUSSION—Also known as heat fusion, thermal fusion, and fusion.

heat mark—extremely shallow depression or groove in the surface of a plastic visible because of a sharply defined rim or a roughened surface. (See also **sink-mark.**) **[D20] D 883**

high-density polyethylene plastics (HDPE), *n*—those linear polyethylene plastics, g.v., having a standard density of 0.941 g/cm^{3}or greater. **[D20] D 883**

homopolymer, *n*—a polymer resulting from polymerization involving a single monomer. **[D20] D 883**

hoop stress—the tensile stress in the wall of the piping product in the circumferential direction due to internal hydrostatic pressure. **[F17.48] D 2837, F 948**

DISCUSSION—Hydrostatic means fluid and is not limited to water. Units will be reported as pounds per square inch (psi) or mega pascals (Mpa). Hoop stress is calculated by using ISO equation. Hoop stress

should only be determined on straight hollow cylindrical specimens. Products of more complex shape may be evaluated by Option 2 of Appendix X1 of F 948 based on pressure.

hydrostatic design basis—one of a series of established stress values specified in Test Method D 2837 for a plastic compound obtained by categorizing the long-term hydrostatic strength determined in accordance with Test Method D 2837. **[F17.48] D 2837**

hydrostatic design stress (HDS)—the estimated maximum tensile stress the material is capable of withstanding continuously with a high degree of certainty that failure of the pipe will not occur. This stress is circumferential when internal hydrostatic water pressure is applied. **[D20.23] D 2104 [F17.25] D 1785, D 2241, F 442/F 442M [F17.26] D 2239, D 2447, D 2666, D 2737, D 3035, F 441/F 441M, F 876, [F17.40] D 2837 [F17.61] D 2282, F 771, D 1527**

impact, Izod—a specific type of impact test made with a pendulum-type machine on a cantilever beam specimen and also the values obtained by this method. **[F17]**

DISCUSSION—See Test Methods D 256.

impact, tup—a falling weight (tup) impact test developed specifically for pipe and fittings. **[F17]**

DISCUSSION—There are several variables that can be selected. (See Test Method D 2444.)

incasement, *n*—a rigid structure or pipe surrounding a buried pipe to provide additional support or protection. **[F17]**

incasement, *v*—placement of a rigid structure or pipe surrounding a buried pipe to provide additional support or protection. **[F17]**

infiltration, pipe—the passage of fluid into a pipe section through small holes or leaks. **[F17]**

inhibitor, *n*—a substance used in low concentration which suppresses a chemical reaction. **[D20] D 883**

DISCUSSION—Inhibitors, unlike catalysts, are consumed during the reaction.

injection molding, *n*—the process of forming a material by forcing it, in a fluid state and under pressure, through a runner system (sprue, runner, gate(s)) into the cavity of a closed mold. **[D20] D 883**

insert, *n*—a part consisting of metal or other material which may be molded into position or may be pressed into the molding after the completion of the molding operation. **ISO [D20] D 883**

insert-fitting joint—see **joint, clamped insert-fitting.**

ISO equation—an equation showing the interrelations between stress, pressure and dimensions in pipe, namely:

$$\frac{S = P\,(ID + t)}{2t} \text{ for inside diameter controlled pipe}$$

or

$$\frac{S = P\,(OD - t)}{2t} \text{ for outside diameter controlled pipe}$$

where:

S = hoop stress,
P = pressure,
ID = average inside diameter,
OD = average outside diameter, and
t = minimum wall thickness.

(See ISO R 161.) **[F17.25] D 1785, F 441/F 441M, F 442/F 442M [F17.26] D 2104, D 2239, D 2447, D 2666, D 2737, D 3035, F 714, F 876 [F17.61] D 1527, D 2282, D 2846/D 2846M, D 3309, F 645, F 771, F 877**

isotactic, *adj*—pertaining to a type of polymeric molecular structure containing a sequence of regularly spaced asymmetric atoms arranged in like configuration in a polymer chain. **[D20] D 883**

joint—the location at which two pieces of pipe or a pipe and a fitting are connected together. **[F17.10] F 2145 [F17.60] F 1924, F 1948, F 1973**

DISCUSSION—The joint may be made by an adhesive, a solvent-cement, heat joining, or a mechanical device such as threads or a ring seal.

joint, adhesive-bonded—a joint made using an adhesive to bond the piping components. **[F17]**

joint, bell and spigot gasket—a connection between piping components consisting of a bell end on one component, an elastomeric gasket between the components, and a spigot end on the other component. See *joint, push on.* **[F17]**

joint, butt-fused—a joint in which the prepared ends of the joint components are heated and then placed in contact to form the joint. (See Fig. 1.) **[F17]**

joint, compression—a mechanical joint made by deforming a sealing member to form a pressure seal between the fitting or pipe bell and the pipe or tube (See Fig. 2). **[F17]**

DISCUSSION—Compression joints include, but are not limited to, insert fitting joints, compression gasket joints and flare joints.

joint, compression gasket—a mechanical joint that utilizes a compression nut or a gland nut against a gasket to develop a

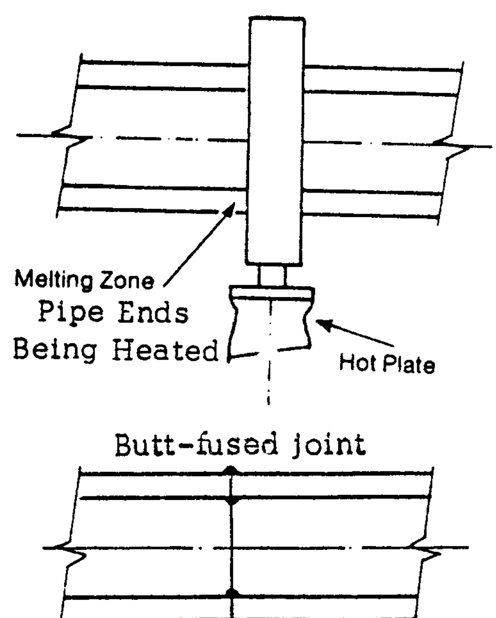

FIG. 1 Butt Fusion

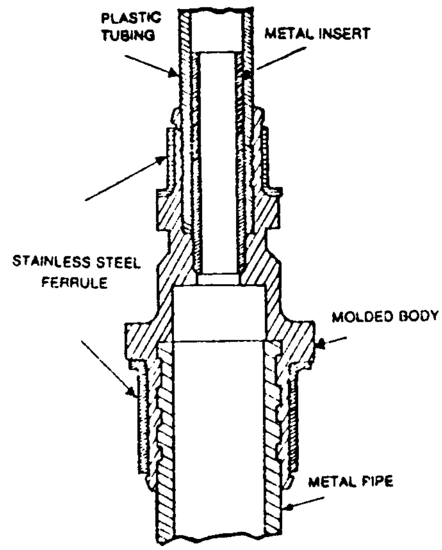

FIG. 2 Compression Fitting

pressure seal. **[F17]**

DISCUSSION—There are currently available various designs of compression gasket joints in fittings, transition fittings, and couplings.

joint, flanged—a mechanical joint using pipe flanges, a gasket, and bolts. **[F17]**

DISCUSSION—The flanges are normally fastened to the pipe or fittings but there are some systems in which the flanges are free to rotate.

joint, flare—a mechanical compression connection between flared-end plastic pipe and a fitting specifically designed to accept flared-end plastic pipe. (See Fig. 3.) **[F17]**

DISCUSSION—A special tool is used to flare plastic pipe.

joint, heat-fused—a joint made using heat and pressure only. **[F17]**

DISCUSSION—The surfaces are heated with special tools until the surfaces have softened. When engaged, the softened surfaces flow together forming a joint as the material cools. There are three basic types of heat-fused joints: butt fused, socket or insert fused, and saddle fused.

joint, insert-fitting—a mechanical joint using external metal clamps, rings, or other devices to form a pressure seal between an insert fitting and the pipe or tube. **[F17]**

DISCUSSION—These joints are a type of compression joint.

joint, mechanical—a connection between piping components employing physical force to develop a seal or produce alignment. **[F17]**

DISCUSSION—Mechanical joints may or may not carry thrust forces across the joint. (Examples of mechanical joints include, but are not limited to threaded joint, compression gasket joint, compression fitting joint, push-on joint, clamped insert fitting joint, flanged joint, or flare joint.)

joint, push on—a joint in which a continuous elastomeric ring gasket is compressed into annular space formed by the pipe or fitting socket and the spigot end of the pipe, and forms a positive seal after being assembled. Details of the joint design and assembly shall be in accordance with the manufacturer's instructions. **[F17.20] D 3139**

DISCUSSION—Sometimes called a bell-and-spigot gasket joint.

joint, saddle-fused—a joint in which the curved base of the saddle fitting and a corresponding area of the pipe surface are heated and then placed together to form the joint. **[F17]**

joint, socket-fused or insert-fused—a joint in which the joining surfaces of the components are heated, and the joint is made by inserting one component into the other. (See Fig. 4 and Fig. 5.) **[F17]**

joint, solvent cement—see **solvent cement joint**.

joint, solvent-cemented—a joint made using a solvent cement to unite the components. **[F17]**

DISCUSSION—The solvent cement softens the surfaces of the components, which then solidify as the solvent evaporates.

joint, solvent—see **solvent joint**.

joint, threaded—a mechanical joint that utilizes threaded pipe and fittings. **[F17]**

DISCUSSION—There are many types of threads, and the same thread configuration must be used for mating components.

knit-line—see **weld-line** (preferred terminology).

laminate, *n*—a product made by bonding together two or more

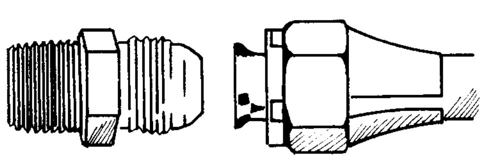

FIG. 3 Flare Joint

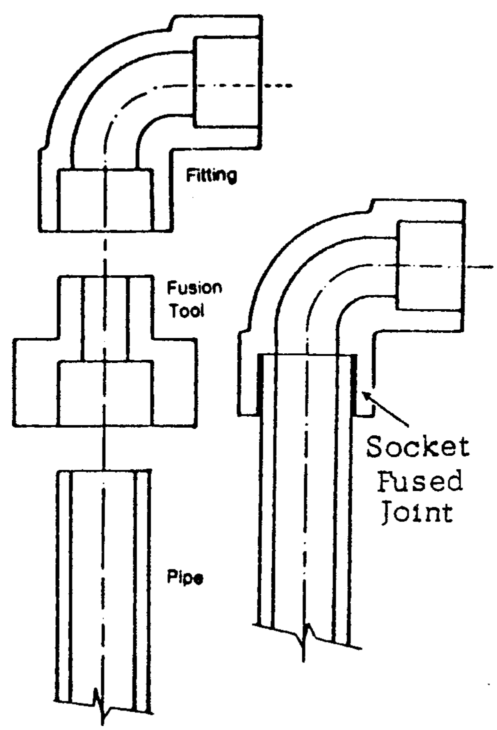

FIG. 4 Socket Fusion

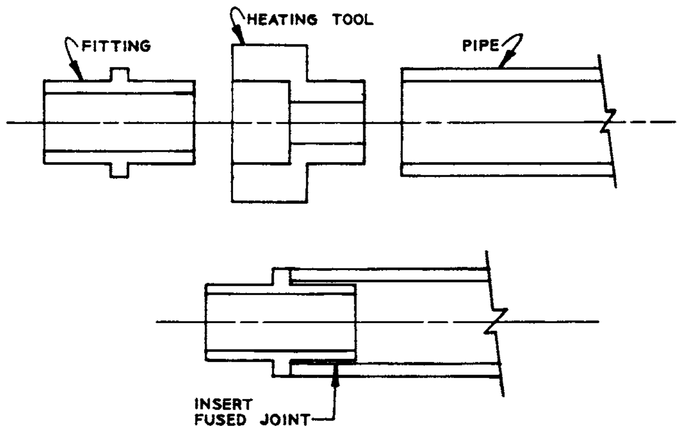

FIG. 5 Insert Fusion

layers of material or materials. (See also **cross laminate** and **parallel laminate**.) **[D20] D 883**

DISCUSSION—A single resin-impregnated sheet of paper, fabric, or glass mat, for example, is not considered a laminate. Such a single-sheet construction may be called a "lamina." (See also **reinforced plastic**.)

laminate, cross—see **cross laminate**.

laminate, parallel—see **parallel laminate**.

laying length—the centerline length of an installed pipeline system, section, or fitting. **[F17]**

DISCUSSION—Laying length of pipe or fitting with overlapping joining elements, for example, spigot and socket, include the entire length reduced by the portion of the spigot that is overlapped. Laying length of pipe or fitting with a spigot on each end is the overall length of the uninstalled section.

live load—portion of load transmitted to the pipe from wheel or traveling loads or other surcharged load. **[F17]**

long-term hydrostatic strength (LTHS)—the hoop stress that when applied continuously will cause failure of the pipe at 100 000 h (11.43 years). **[F17.40] D 2837**

DISCUSSION—These strengths are usually obtained by extrapolation of log-log regression equations or plots. Typical conditions are water at 23°C.

lot, *n*—a lot shall consist of all pipe and fittings or appurtenances of the same size produced from one extrusion line or molding machine during one designated period. **[F17.10] F 1970 [F17.11] F 1335, F 1488, F 1986, F 1987 [F17.25] F 891 [F17.63] D 2661, F 628, F 1499**

low-density polyethylene plastics (LDPE), *n*—those branched polyethylene plastics, q.v., having a standard density of 0.910 to 0.925 g/cm^3. **[D20] D 883**

lubricant, *n*—(*1*) a material used to reduce the friction between two mating surfaces that are being joined by sliding contact. (*2*) an additive that is added to a plastic compound to lower the viscosity or otherwise improve the processing or product characteristics. **[F17]**

mechanical cleaner—see **cleaner, mechanical.**

mechanical joint—see **joint, mechanical.**

medium density polyethylene plastics (MDPE) , *n*—those branched polyethylene plastics, q.v., having a standard density of 0.926to 0.940 g/cm^3. **[D20] D 883**

melt index—the flow rate of PE material when measured in accordance with Test Method D 1238. **[F17]**

minimum required pressure—one of a series of established pressure values for a plastic piping component (multilayer pipe, fitting, valve, and so forth) obtained by categorizing the long-term hydrostatic pressure strength in accordance with ISO 9080. **[F17]**

minimum required strength—one of a series of established stress values for a plastic compound obtained by categorizing the long-term hydrostatic strength determined by hydrostatic testing in accordance with ISO 9080. **[F17]**

molding, blow—see **blow molding**.

molding, cold—see **cold molding**.

molding, compression—see **compression molding**.

molding, contact pressure—a method of molding or laminating in which the pressure is only slightly more than necessary to hold the materials together during the molding operation. This pressure is usually less than 69 kPa (10 psi). **[D20] D 883**

molding, high-pressure—a method of molding or laminating in which the pressure used is greater than 1400 kPa (200 psi). **[D20] D 883**

molding, injection—see **injection molding**.

molding, low-pressure—a method of molding or laminating in which the pressure used is 1400 kPa (200 psi) or less. **[D20] D 883**

molding pressure, compression—the calculated fluid pressure applied to the material in the mold. **[D20] D 883**

molding pressure, injection—the pressure applied to the cross-sectional area of the material cylinder. **[D20] D 883**

molding pressure, transfer—the pressure applied to the cross-sectional area of the material pot or cylinder. **[D20] D 883**

molding, transfer—see **transfer molding**.

monomer, *n*—low–molecular weight substance consisting of molecules capable of reacting with like or unlike molecules to form a polymer. (See also **polymer**.) **[D20] D 883**

multilayer pipe, *n*—A pipe constructed of multiple layers that are bonded to each other and in which at least 60% of the wall thickness consists of polymeric material(s). **[F17]**

DISCUSSION—The different layers of polymeric or other kinds of material in a multilayer pipe may provide color, barrier, stiffness, strength of other properties for an intended application. In the US and Canada sometimes multilayer is referred to as composite pipe.

In the case of multilayer pipes intended for pressure applications two types of pipes are recognized as follows:

Type 1 multilayer pipe—A pressure rated pipe in which at least 60% of its wall thickness is comprised of a polymeric material that has an established HDB (Hydrostatic Design Basis) or MRS (Minimum Required Strength) from which the pressure rating of the pipe is determined.

DISCUSSION—An example of this type is co-extruded plastic pipe with an outer layer for barrier or color purposes. If this outer layer has the same HDB as the bulk wall, the entire wall thickness is used for pressure calculations; if not, only the bulk wall that has an HDB/MRS rating is used for pressure calculations.

Type 2 multilayer pipe—A pressure rated pipe in which at least 60% of the wall thickness is comprised of a polymeric material, and for which the pipe pressure rating has been determined for each pipe size and pipe wall construction based on the pipe's experimentally established PDB (Pressure Design Basis) or MRP (Minimum Required Pressure).

DISCUSSION—An example of this type of pipe is PEX/AL/PEX.

necking, *n*—the localized reduction in cross section which may occur in a material under tensile stress. **[D20] D 883**

non-pressure pipe—pipe designed for gravity-conveyed medium which must resist only intermittent static pressures and does not have a pressure rating. **[F17]**

non-standard virgin material—a plastic resin or compound in the form of powder or pellets which does not meet the specification requirements for which it was manufactured, and has not been subjected to use or processing other than that required for its initial manufacture. **[F17]**

DISCUSSION—"Wide-spec," "off-spec," and "non-uniform virgin material" are industry terms synonymous with this definition.

nylon plastics—plastics based on resins composed principally of a long-chain synthetic polymer amide which has recurring amide groups as an integral part of the main polymer chain. **[D20] D 883**

olefin plastics—plastics based on polymers made by the polymerization of olefins or copolymerization of olefins with other monomers, the olefins being at least 50 mass %. **[D20] D 883**

oligomer, *n*—substance composed of only a few nonomeric units repetitively linked to each other, such as a dimer, trimer, tetramer, etc., or their mixtures. **[D20] D 883**

open-cell cellular plastic, *n*—a cellular plastic in which there is a predominance of interconnected cells. **[D20] D 883**

orange-peel—uneven surface somewhat resembling an orange peel. **[F17]**

outdoor exposure—normal weather conditions, that is, the sun's rays, rain, air, temperature changes, and wind. **[F17]**

DISCUSSION—Exposure to atmospheres containing pollutants in excess of imposed federal, state, and local air quality standards is not considered normal "outdoor exposure."

out-of-roundness—the allowed difference between the maximum measured diameter and the minimum measured diameter (stated as an absolute deviation). **[F17.11] F 1488** **[F17.63] F 1499**

ovality—(%),

$$\frac{(\text{maximum measured diameter} - \text{minimum measured diameter})}{\text{average measured diameter}} \times 100$$

[F17]

overall length—the total length of the individual pipeline system, section, or fitting prior to installation. **[F17]**

parallel laminate—a laminate in which all the layers of material are oriented approximately parallel with respect to the grain or strongest direction in tension. (See also **cross laminate**.) **[D20] D 883**

parison, *n*—the shaped plastic mass, generally in the form of a tube, used in blow molding. **ISO/ [D20] D 883**

pimple, *n*—small, sharp, or conical elevation on the surface of a plastic. **[F17]**

pipe, beveled—see **beveled pipe**.

pipe, composite—see **composite pipe**.

pipe, exfiltration—see **exfiltration pipe**.

pipe, infiltration—see **infiltration pipe**.

pipe, multilayer—see **multilayer pipe**.

pipe, non-pressure—see **non-presssure pipe**.

pipe, pressure—see **pressure-pipe**.

pipe spigot—portion of a pipe or fitting which fits into a bell or socket of a preceeding pipe or fitting. **[F17]**

pipe zone backfill—backfill in the area of the pipe, may be specified for depth and compaction. **[F17]**

pit, *n*—an imperfection, a small crater in the surface of the plastic, with its width approximately the same order of magnitude as its depth. **[D20] D 883**

plastic(s), *n*—a material that contains as an essential ingredient one or more organic polymeric substances of large molecular weight, is solid in its finished state, and, at some stage in its manufacture or processing into finished articles, can be shaped by flow. **[D20] D 883**

NOTE 1—Rubber, textiles, adhesives, and paint, which may in some cases meet this definition, are not considered plastics. See ASTM definitions of these terms.

NOTE 2—The above definition may be used as a separate meaning to the definitions contained in the dictionary for the adjective "plastic."

NOTE 3—The plural form may be used as an adjective to refer to two or more plastic materials, for example, plastics industry. However, when the intent is to distinguish "plastic products" from "wood products" or "glass products," the singular form should be used. As a general rule, if the adjective is to restrict the noun modified with respect to the type of material, "plastic" should be used; if the adjective is to indicate that more than one type of plastic material is or may be involved," plastics" is permissible.

plastic conduit—plastic pipe or tubing used as an enclosure for electrical wiring. **[F17]**

plasticizer, *n*—a substance incorporated in a material to increase its workability, flexibility, or distensibility. **[D20] D 883**

plastic, cellular—see **cellular plastic**.

plastic, expandable—see **expandable plastic**.

plastic, fluorocarbon—see **fluorocarbon plastic**.

plastic, open-cell cellular—see **open-cell cellular plastic**.

pipe, beveled—see **beveled pipe**.

plastic pipe—a hollow cylinder of a plastic material in which the wall thicknesses are usually small when compared to the diameter and in which the inside and outside walls are essentially concentric. **[D20] D 883**

plastic, reinforced—see **reinforced plastic**.

plastic, reprocessed—see **reprocessed plastic**.

plastic, rework (thermoplastic)—see **rework plastic (thermoplastic)** .

plastic, semirigid—see **semirigid plastic**.

plastic, thermally foamed—see **thermally foamed plastic**.

plastic tubing, *n*—a particular size of smooth wall plastic pipe in which the outside diameter is essentially the same as the corresponding size of copper tubing. **[F17]**

plastic, virgin—see **virgin plastic**.
plastics, acetal—see **acetal plastics**.
plastics, acrylonitrile-butadiene-styrene (ABS) pipe and fitting plastics—see **acrylonitrile-butadiene-styrene (ABS) pipe and fitting plastics**.
plastics, butylenes—see **butylenes plastics**.
plastics, cellulose acetate butyrate (CAB)—see **cellulose acetate butyrate(CAB) plastics**.
plastics, chlorinated poly (vinyl chloride)—see **chlorinated poly(vinyl chloride) plastics**.
plastics, chlorofluorocarbon—see **chlorofluorocarbon plastics**.
plastics, chlorofluorohydrocarbon—see **chlorofluorohydrocarbon plastics**.
plastics, closed-cell cellular—see **closed-cell cellular plastics**.
plastics, engineering —see **engineering plastics**.
plastics, ethylene—see **ethylene plastics**.
plastics, fluorohydrocarbon—see **fluorohydrocarbon plastics**.
plastics, high-density polyethylene (HDPE)—see **high-density polyethylene plastics (HDPE)**.
plastics, low-density polyethylene (LDPE)—see **low-density polyethylene plastics (LDPE)**.
plastics, medium-density polyethylene (MDPE)—see **medium-density polyethylene plastics (MDPE)**.
plastics, nylon—see **nylon plastics**.
plastics, olefin—see **olefin plastics**.
plastics, polybutylene—see **polybutylene plastics**.
plastics, polyethylene—see **polyethylene plastics**.
plastics, polyolefin—see **polyolefin plastics**.
plastics, polypropylene—see **polypropylene plastics**.
plastics, propylene—see **propylene plastics**.
plastics, styrene—see **styrene plastics**.
plastics, styrene-rubber (SR) pipe and fitting—see **styrene-rubber (SR) pipe and fitting plastics**.
plastics, styrene-rubber —see **styrene-rubber plastics**.
plastics, vinyl chloride—see **vinyl chloride plastics**.
vinylidene chloride—see **vinylidene chloride plastics**.

polybutylene, *n*—a polymer prepared by the polymerization of butene as the sole monomer. (See polybutylene plastics and butlenes plastics.) **[D20] D 883**

polybutylene plastics, *n*—plastics based on polymers with butene as essentially the sole monomer. **[D20] D 883**

polyethylene, *n*—a polymer prepared by the polymerization of ethylene as the sole monomer. **[D20] D 883**

polyethylene plastics—plastics based on polymers made with ethylene as essentially the sole monomer. **[D20] D 883**

Discussion—In common usage for this plastic, essentially means no less than 85 % ethylene and no less than 95 % total olefins.

polymer, *n*—a substance consisting of molecules characterized by the repetition (neglecting ends, branch junctions, and other minor irregularities) of one or more types of monomeric units., **IUPAC [D20] D 883**

polyolefin, *n*—a polymer prepared by the polymerization of an olefin(s) as the sole monomer(s). **[D20] D 883**

polyolefin plastics, *n*—plastics based on polymers made with an olefin(s) as essentially the sole monomer(s). **[D20] D 883**

polypropylene, *n*—a polymer prepared by the polymerization of propylene as the sole monomer. **[D20] D 883**

polypropylene plastics—plastics based on polymers made with propylene as essentially the sole monomer. **[D20] D 883**

polystyrene, *n*—a polymer prepared by the polymerization of styrene as the sole monomer. **[D20] D 883**

poly(vinyl acetate), *n*—a polymer prepared by the polymerization of vinyl acetate as the sole monomer. **[D20] D 883**

poly(vinyl chloride)—a polymer prepared by the polymerization of vinyl chloride as the sole monomer. (vinyl chloride content in monomer not less than 99%. **[D20] D 883**

pot life—the period of time during which a reacting thermosetting composition remains suitable for its intended processing after mixing with reaction-initiating agents. **[D20] D 883**

pressure—when expressed with reference to pipe, the force per unit area exerted by the test fluid in the piping product . Units will be reported as pounds per square inch gage (psig) or mega pascals gage (MPag). **[D17.40] D 2837, F 948**

pressure design basis (PDB)—one of a series of established pressure values for a plastic piping component (multilayer pipe, fitting, valve) obtained by categorizing the long-term hydrostatic pressure strength (LTHPS) determined in accordance with an industry test method that uses linear regression analysis. **[F17.40] D 2837**

Discussion—Although Test Method D 2837 does not use "pressure values," the PPI Hydrostatic Stress Board uses the principles of Test Method D 2837 in plotting log pressure versus log time to determine a "long-term hydrostatic pressure strength" and the resulting "Pressure Design Basis" for multilayer pipe that is listed in PPI TR-4.

pressure pipe—pipe designed to resist continuous pressure exerted by the conveyed medium. **[F17]**

pressure rating (PR)—the estimated maximum water pressure the pipe is capable of withstanding continuously with a high degree of certainty that failure of the pipe will not occur. The PR and HDS/HDB are related by the following equation.

$$PR = 2\,(HDB)\,(DF)/(SDR{-}1) = 2\,(HDS)/(SDR{-}1) \tag{1}$$

The PR and PDB are related by the following equation:

$$PR = (PDB)\,(DF) \tag{2}$$

[F17.11] F 1335, F 1986, F 1987[F17.25] D 1785, D 2241, F 441/F 441M, F 442/F 442M [F17.26] D 2104, D 2239, D 2447, D 2737, D 3035, F 876 [F17.40] D 2837 [F17.61] D 1527, D 2282, F 771

primer—an organic solvent or a blend of solvents, which enhances adhesion, applied to plastic pipe and fittings prior to application of a solvent cement. **[17.20] F 402**

propylene plastics, *n*—plastics based on polymers of propylene or copolymers of propylene with other monomers, the propylene being in the greatest amount by mass. **ISO [D20] D 883**

push-on joint—see **joint, push-on.**

qualification test—an evaluation, generally nonrepetitive, conducted on an existing, altered, or new product to determine acceptability. **[F17]**

qualification testing—testing performed on a product to determine whether or not the product conforms to requirements of an applicable specification. **[F17]**

quality assurance test—a test in a program which is conducted to determine the quality level. **[F17]**

DISCUSSION—Quality assurance includes quality control, quality evaluation, and design assurance. A good quality assurance program is a coordinated system, not a sequence of separate and distinct steps.

quality control test—an in-plant test that is conducted on a given test frequency to determine whether product is in accordance with the appropriate specification(s). **[F17]**

quick burst—Not a preferred term (see **quick burst test, quick burst pressure,** and **quick burst strength**).

quick burst pressure—the internal pressure required to bring a piping component to failure when subjected to a quick burst test. **[F17]**

quick burst strength—the hoop stress resulting from the quick burst pressure. **[F17]**

quick burst test—an internal pressure test designed to produce failure of a piping component over a relatively short period of time, usually measured in seconds.

referee test—a test made to settle a disagreement as to conformance to specified requirements. **[F17]**

DISCUSSION—Modified from a definition in Test Methods C 114.

reinforced plastic—a plastic with high strength fillers imbedded in the composition, resulting in some mechanical properties superior to those of the base resin. (See also **filler**.) **[D20] D 883**

DISCUSSION—The reinforcing fillers are usually fibers, fabrics, or mats made of biers.

release agent, *n*—a material added to a compound or applied to the mold cavity, or both, to reduce parts sticking to the mold. **[D20] D 883**

reprocessed plastic—a thermoplastic prepared from usually melt processed scrap or reject parts by a plastics processor, or from non-standard or non-uniform virgin material. **[D20] D 883**

DISCUSSION—Use of the term "scrap" in this definition does not connote that the feed stock is necessarily less desirable or usable than the virgin material from which it may have been generated. Reprocessed plastic may or may not be reformulated by the addition of fillers, plasticizers, stabilizers, pigments, etc.

resin, *n*—a solid or pseudosolid organic material, often of high molecular weight, which exhibits a tendency to flow when subjected to stress, usually has a softening or melting range, and usually fractures conchoidally. **[D20] D 883**

DISCUSSION—In a broad sense, the term is used to designate any polymer that is a basic material for plastics.

rework plastic (thermoplastic)—a plastic from a manufacturer's own production that has been reground or pelletized for reuse by that same manufacturer. **[F17]**

DISCUSSION—In many specifications the use of reworked material is limited to clean plastic that meets the requirements specified for virgin material, and yields a product equal in quality to one made from only virgin material. See **recycled plastic** and **reprocessed plastic**.

rubber—a material that is capable of recovering from large deformations quickly and forcibly, and can be, or already is, modified to a state in which it is essentially insoluble (but can swell) in boiling solvent, such as benzene, methylethylketone, and ethanoltoluene azeotrope.

A rubber in its modified state, free of diluents, retracts within 1min to less than 1.5 times its original length after being stretched at room temperature (18 to 29°C) to twice its length and held for 1 min before release. (D-11) **[D11] D 1079**

runner, *n*—(*1*) the secondary feed channel in an injection or transfer mold that runs from the inner end of the sprue to the cavity gate.

(*2*) the piece formed in a secondary feed channel or runner. **[D20] D 883**

saddle-fused joint—see **joint, saddle-fused.**

sample—one or more units of product randomly selected from a lot to represent that lot. **[F17]**

schedule—a pipe size system (outside diameters and wall thicknesses) originated by the iron pipe industry. **[F17]**

semirigid plastic, *n*—for the purposes of general classification, a plastic that has a modulus of elasticity either in flexure or in tension of between 70 and 700 MPa (10 000 and 100 000 psi) at 23°C and 50% relative humidity when tested in accordance with Test Method D 638, Test Method D 747, Test Method D 790, or Test Method D 882. **[D20] D 883**

service factor—a factor which is used to reduce a strength value to obtain an engineering design stress. The factor may vary depending on the service conditions, the hazard, the length of service desired, and the properties of the pipe. **[F17]**

set, *n*—strain remaining after complete release of the force producing the deformation. **[D20] D 883**

set, *v*—to convert an adhesive into a fixed or hardened state by physical or chemical action, such as condensation, polymerization, oxidation, vulcanization, gelation, hydration, or evaporation of volatile constituents. **[D14] D 907**

short, *n*—an imperfection in molded plastic part due to, an incompletely filled out condition. **[D20] D 883**

DISCUSSION—This may be evident either through an absence of surface film in some areas, or as lighter unfused particles of material showing through a covering surface film, accompanied possibly by thin-skinned blisters.

shrink mark—an imperfection, a depression in the surface of a molded material where it has retracted from the mold. **[D20] D 883**

skin, *n*—a relatively dense layer at the surface of a cellular polymeric material. **[D20] D 883**

slit failure—a form of brittle failure which exhibits only a very small crack through the wall of the pipe with no visible (to the naked eye) material deformation in the area of the break. **[F17]**

socket—the portion of a jointing system that is designed to accept a plain-end pipe or spigot-end pipe. **[F17]**

socket end—the end portion of a piping component which is designed to accept a plain-end piping component or spigot-end piping component. **[F17]**

socket-fused joint—see **joint, socket-fused.**

soil compaction—see **compaction, soil.**

solvent cement—an adhesive made by dissolving a plastic resin or compound in a suitable solvent or mixture of solvents. The solvent cement dissolves the surfaces of the pipe and fittings to form a bond between the mating surfaces provided the proper cement is used for the particular materials and proper techniques are followed. **[F17]**

solvent-cemented joint—see **joint, solvent-cemented.**

solvent cementing—making a pipe joint with a solvent cement. (See **solvent cement**.) **[F17]**

solvent cement joint—a joint made by using a solvent cement to unite the components. **[F17]**

DISCUSSION—The solvent cement softens or dissolves the surfaces of the components, which then solidify as the solvent evaporates.

solvent joint—a joint made by using a solvent to unite the components. **[F17]**

DISCUSSION—The solvent softens or dissolves the surfaces of the components which then solidify as the solvent evaporates.

specifying agency—the individual engineer, firm, or political subdivision charged with and having responsibility for the design of a facility, product, equipment, or material requirements. **[F17]**

specimen, *n*—a piece or portion of a sample used to make a test. **ISO/ [D20] D 883**

spring line—a line along the length of the pipe at its maximum width along a horizontal plane. **[F17]**

sprue, *n*—(*1*) the primary feed channel that runs from the outer face of an injection or transfer mold, to the mold gate in a single cavity mold or a runner in multiple-cavity mold; (*2*) the piece of material formed in the primary feed channel opening. **[F17]**

stabilizer—an ingredient added to a plastic to retard possible degradation. **[F17]**

DISCUSSION—Generally added for processing heat protection or for environmental protection, or both.

standard dimension ratios (SDR)—a specific ratio of the average specified outside diameter to the minimum specified wall thickness (D_0/t) for outside diameter-controlled plastic pipe, the value of which is derived by adding one to the pertinent number selected from the ANSI Preferred Number Series 10. Some of the values are as follows:

ANSI Preferred Number Series 10	SDR
5.0	6.0
6.3	7.3
8.0	9.0
10.0	11.0
12.5	13.5
16.0	17.0
20.0	21.0
25.0	26.0
31.5	32.5
40.0	41.0
50.0	51.0
63.0	64.0

(See reference: ANSI Preferred Numbers, Z17.1 (Designated as R 10 in ISO 3 and ISO 497).) **[F17]**

standard inside diameter dimension ratio (SIDR)—a specific ratio of the average specified inside diameter to the minimum specified wall thickness (D_i/t) for inside diameter-controlled plastic pipe, the value of which is derived by subtracting one from the pertinent number selected from the ANSI Preferred Number Series 10. Some of the values are as follows:

ANSI Preferred Number Series 10	SIDR
5.0	4.0
6.3	5.3
8.0	7.0
10.0	9.0
12.5	11.5
16.0	15.0
20.0	19.0
25.0	24.0
31.5	30.5
40.0	39.0
50.0	49.0
63.0	62.0

(See reference: ANSI Preferred Numbers, Z17.1 (Designated as R 10 in ISO 3 and ISO 497).) **[F17]**

strain—the change per unit of length in a linear dimension of a body, that accompanies a stress. **[F17]**

DISCUSSION—Strain is a dimensionless quantity which may be measured conveniently in percent, in inches per inch, in millimetres per millimetre, etc.

strength—the stress required to break, rupture, or cause a failure. **[F17]**

strength design basis—one of a series of established stress values (specified in Test Method D 2837) for a plastic molding compound obtained by categorizing the long-term strength determined in accordance with Test Method F 2018. **[F17]**

DISCUSSION—The SDB is used only for a material intended for molding applications. The SDB shall not be used for pipe applications.

stress crack, environmental, *n*—a stress crack, the development of which has been accelereated by the environment to which the plastic is exposed. (See **stress-crack**.) **[F17]**

stress, hoop—see **hoop stress**.

stress relaxation—the decrease in stress, at constant strain, with time. **[F17]**

styrene plastics, *n*—plastics based on polymers of styrene or copolymers of styrene with other monomers, the styrene being the greatest amount by mass. **ISO [D20] D 883**

styrene-rubber (SR) pipe and fitting plastics—plastics containing at least 50% styrene plastics combined with rubbers and other compounding materials, but not more than 15 % acrylonitrile. **[F17]**

styrene-rubber plastics, *n*—plastics based on styrene polymers and rubbers, the styrene polymers being in the greatest amount by mass. **ISO [D20] D 883**

sustained pressure test—a constant internal pressure test for an extended period of time. **[F17]**

DISCUSSION—One thousand hours is a commonly used period of time.

sweep—see **bend**.

syneresis, *n*—the contraction of a gel accompanied by the separation of a liquid. **ISO [D20] D 883**

telomer, *n*—a polymer composed of molecules having terminal groups incapable of reacting with additional monomers, under the conditions of the synthesis, to form larger polymer molecules of the same chemical type. **ISO, IUPAC, [D20] D 883**

test section—portion(s) of a pipe, fitting, or pipeline under test. **[F17]**

test, qualification—see **qualification test**.

test, quality assurance—see **quality assurance test**.

test, quality control—see **quality control test**.

test, quick burst—see **quick burst test**.

test, referee—see **referee test**.

test, sustained pressure—see **sustained pressure test**.

testing, acceptance—see **acceptance testing**.

testing, elevated temperature—see **elevated temperature testing**.

testing, qualification—see **qualification testing**.

thermally foamed plastic—a cellular plastic produced by applying heat to effect gaseous decomposition or volatilization of a constituent. **[D20] D 883**

thermoplastic, *n*—a plastic that repeatedly can be softened by heating and hardened by cooling through a temperature range characteristic of the plastic, and that in the softened state can be shaped by flow into articles by molding or extrusion. **[D20] D 883**

thermoplastic, *adj*—capable of being repeatedly softened by heating and hardened by cooling through a temperature range characteristic of the plastic, and that in the softened state can be shaped by flow into articles by molding or extrusion for example. **[D20] D 883**

Discussion—Thermoplastic applies to those materials whose change upon heating is substantially physical.

thermoplastic piping compound—a mixture of a thermoplastic polymer with other ingredients such as fillers, stabilizers, catalysts, processing aids, lubricants, modifiers, pigments, or curing agents, but not plasticizers except in the case of CAB piping compound. **[F17]**

thermoset, *n*—a plastic that, after having been cured by heat or other means, is substantially infusible and insoluble. **[D20] D 883**

thermosetting, *adj*—capable of being changed into a substantially infusible or insoluble product when cured by heat or other means. **[D20] D 883**

toe-in—a small reduction of the outside diameter at the cut end of a length of thermoplastic pipe. **[F17]**

transfer molding—a method of forming articles by fusing a plastic material in a chamber and then forcing essentially the whole mass into a hot mold where it solidifies. **[D20] D 883**

transition, first order—a change of state, associated with crystallization or melting in a polymer. **[D20] D 883**

vinyl chloride plastics—plastics based on polymers of vinyl chloride or copolymers of vinyl chloride with other monomers, the vinyl chloride being in the greatest amount by mass. **ISO/[D20] D 883**

vinylidene chloride plastics—plastics based on polymer resins made by the polymerization of vinylidene chloride or copolymerization of vinylidine chloride with other unsaturated compounds, the vinylidene chloride being in the greatest amount by weight. **[D20] D 883**

virgin plastic—a plastic material in the form of pellets, granules, powder, floc, or liquid that has not been subjected to use or processing other than that required for its initial manufacture. **[D20] D 883**

viscosity—the property of resistance to flow exhibited within the body of a material. **[D20] D 883**

Discussion—This property can be expressed in terms of the relationship between shear stress and corresponding rate of strain in shear. Viscosity is usually taken to mean "Newtonian Viscosity," in which case the ratio of shearing strain is constant. In non-Newtonian behavior, which is usual with plastic materials, the ratio varies with the parameters of the experiment. Such ratios are often called "apparent viscosities." (See **viscosity coefficient**.).

viscosity coefficient—the shearing stress necessary to induce a unit velocity flow gradient in a material. **[D20] D 883**

Discussion—In actual measurement, the viscosity coefficient of a material is obtained from the ratio of shearing stress to shearing rate. This assumes the ratio to be constant and independent of the shearing stress, a condition which is satisfied only by Newtonian fluids. Consequently, in all other cases, values obtained are apparent and represent one point on the flow curve. The viscosity coefficient is expressed in pascal-seconds (or poises). (See **viscosity**.)

void, *n*—(*1*) in a solid plastic, an unfilled space of such size that it scatters radiant energy such as light.

(*2*) a cavity unintentionally formed in a cellular material and substantially larger than the characteristic individual cells. **ISO [D20] D 883**

vulcanization, *n*—an irreversible process during which a rubber compound, through a change in its chemical structure (for example, cross-linking), becomes less plastic and more resistant to swelling by organic liquids and elastic properties are conferred, improved, or extended over a greater range of temperature. **[D20] D 883**

water service—the pipe from the water main or other source of water supply to the building or other point of use or distribution. **[F17]**

weld-mark, *n*—a visible weld line. **[D20] D 883**

width—in the case of a beam, the cross—sectional dimension perpendicular to the direction in which the load is applied. **[D20] D 883**

ANNEX

(Mandatory Information)

A1. GLOSSARY – HYPHENATION

A1.1 In F17 standards the following word combinations should be hyphenated:

- intercept-values category
- pressure-intercept value
- pressure-regression line
- pressure-rating categories

A1.2 In F17 standards the following word combinations need not be hyphenated:

- external pressure test
- internal pressure test
- tensile strength requirements
- tensile strength test
- mechanical joint qualification test
- constant load test
- long term creep
- assembled test specimen
- mechanical joint performance test
- medium tensile load
- cross sectional area
- long term data
- fitting failure data
- long term hydrostatic pressure rating
- long term pressure rating
- fitting pressure rating
- socket type fitting
- mechanical end closure
- solvent cemented cap
- solvent cement joint
- primary fitting pattern
- short term data
- Lower Confidence Line (LCL)
- water filled pipe
- fitting material type and grade
- socket wall thickness
- minimum wall thickness
- cell class
- data point requirements
- long term testing
- system pressure needs

Exhibit E

Designation: F2159 – 10

An American National Standard

Standard Specification for
Plastic Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing[1]

This standard is issued under the fixed designation F2159; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification establishes requirements for sulfone plastic insert fittings and copper crimp rings for four sizes (3⁄8 , 1⁄2 , and 3⁄4 and 1) of cross-linked polyethylene (PEX) plastic tubing an polyethylene of raised temperature (PE-RT) tubing. These fittings are intended for use in 100 psi (690 kPa) cold- and hot-water distribution systems operating at temperatures up to and including 180°F (82°C). Included are the requirements for material, molded part properties, performance, workmanship, dimensions, and markings to be used on the fittings and rings.

1.2 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 The following is an index of the appendix in this specification:

GO/NO-GO Crimp Gauges	Appendix X1

1.4 The following precautionary caveat pertains only to the test method portions, Sections 11 and 12, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing
D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
D1599 Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings
D1600 Terminology for Abbreviated Terms Relating to Plastics
D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
D6394 Specification for Sulfone Plastics (SP)
F412 Terminology Relating to Plastic Piping Systems
F876 Specification for Crosslinked Polyethylene (PEX) Tubing
F877 Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems
F1498 Specification for Taper Pipe Threads 60° for Thermoplastic Pipe and Fittings
F1807 Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing
F2623 Specification for Polyethylene of Raised Temperature (PE-RT) SDR 9 Tubing
F2769 Specification for Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems

2.2 *ASME Standard:*

B 1.20.1 Pipe Threads General Purpose Inch[3]

2.3 *NSF International Standard:*

ANSI/NSF Standard No. 14 for Plastic Piping Components and Related Materials [4]
ANSI/NSF Standard No. 61 for Drinking Water System Components-Health Effects [4]

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology F412 and abbreviations are in accordance with Terminology D1600, unless otherwise indicated.

4. Classification

4.1 This specification governs one class of fittings and copper crimp rings suitable for use with nominal size 3⁄8 , 1⁄2 ,3⁄4

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.10 on Fittings.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, http://www.nsf.org.

***A Summary of Changes section appears at the end of this standard.**

and 1 size PEX tubing that meets the requirements of ASTM Specifications F876 or F877 and PE-RT tubing that meets the requirements of Specifications F2623 and F2769.

5. Materials and Manufacture

5.1 *Material*—Fittings shall be molded from sulfone plastic (SP) as specified in Specification D6394. The material shall be unreinforced polysulfone (group 01, class 1, grades 1 or 2) or polyphenylsulfone (group 03, class 1, grade 1 or 2) or unreinforced polyphenylsulfone/polysulfone blends (group 04, Class 2, grade 1) or reworked plastic in accordance with 5.1.1. Pigmented products can exceed the maximum specific gravity listed provided that they comply with all other properties listed in Specification D6394 Table SP.

NOTE 1—Since fittings specified by this standard will be used in hot-and-cold water plumbing systems, a material used to manufacture fittings in accordance with this specification must demonstrate qualities consistent with that application in addition to the performance requirements of this specification. Those qualifying characteristics include, but are not limited to, an established hydrostatic design basis (HDB) or stress design basis (SDB) in accordance with PPI TR-3 or similar rating and a demonstration of resistance to the long-term effects of those chemicals normally found in potable water at the maximum temperature stated in this specification.

5.1.1 *Rework Material*—Clean rework material of the same commercial designation, generated from the manufacturer's own production may be used by the same manufacturer, provided the fittings meet all of the requirements of this specification. Reworked material shall not be introduced at a ratio exceeding 25 %.

5.2 *Potable Water Requirements*—Products intended for the transport of potable water shall be evaluated, tested and certified for conformance with ANSI/NSF Standard No. 61 or the health effects portion of ANSI/NSF Standard No. 14 by an acceptable certifying organization when required by the regulatory authority having jurisdiction.

5.3 *Crimp Rings*—Crimp rings shall be manufactured and marked in accordance with the requirements of Specification F1807.

6. Molded Part Properties

6.1 *Insert Crush*—The fitting insert shall not crack, split, or shatter when tested in accordance with 12.1.

6.2 *Splay*—The molded part shall be free of visible splay excepting some slight blushing at the gate location.

7. Performance Requirements

7.1 *General*—All performance tests shall be performed on assemblies of fittings, crimp rings, and PEX tubing or PE-RT tubing, or both. Fittings and crimp rings shall meet the material and dimensional requirements of this standard. PEX tubing shall meet the requirements of Specifications F876 or F877. PE-RT tubing shall meet the requirements of Specifications F2623 and F2769. Assembly of test specimens shall be in accordance with Section 10. Use separate sets of assemblies for each performance test requirement.

7.2 *Hydrostatic Burst*—Assemblies shall meet the minimum hydrostatic burst requirements shown in Table 1, when tested in accordance with 11.5.

TABLE 1 Minimum Hydrostatic Burst Strength Requirements for Fitting, Crimp Ring, and PEX Tubing or PE-RT Tubing Assemblies

Nominal Tubing Size	Minimum Burst Pressures at Different Temperatures			
in.	psig[A] at 73.4°F	(kPa) at (23°C)	psig[A] at 180°F	(kPa) at (82.2°C)
⅜	620	(4275)	275	(1896)
½	480	(3309)	215	(1482)
¾ and larger	475	(3275)	210	(1448)

[A] The fiber stress to derive this test pressure is: at 73.4°F (23.0°C) 1900 psi (13.10 MPa) at 180°F (82.2°C) 850 psi (5.86 MPa).

7.3 *Hydrostatic Sustained Pressure Strength*—Assemblies shall meet the hydrostatic sustained pressure requirements shown in Table 2 when tested in accordance with 11.6.

7.4 *Thermocycling*—Assemblies shall not leak or separate when thermocycled 1000 cycles between the temperatures of 60°F (16°C) and 180°F (82°C) when tested in accordance with 11.7.

7.5 *Excessive Temperature-Pressure Capability*:

7.5.1 *General*—Assemblies shall have adequate strength to accommodate short-term conditions, 30 days (720 h) of 210° F (99° C) and 150 psi (1034 kPa) when tested in accordance with 11.8.

8. Dimensions

8.1 *Dimensions and Tolerances*—The dimensions and tolerances of fittings shall be as shown in Fig. 1, when measured in accordance with 11.4.

8.1.1 *Alignment*—The maximum angular variation of any opening shall not exceed 1° off the true centerline axis.

8.1.2 *Tapered Threads*—Fitting threads shall be American National Standard Taper Pipe Thread Form conforming to Specification F1498.

8.1.3 *Straight Threads*—Straight pipe threads, intended for the making of a gasketed seal with taper pipe threads, shall be NPSM and conform to ASME B 1.20.1.

9. Workmanship, Finish and Appearance

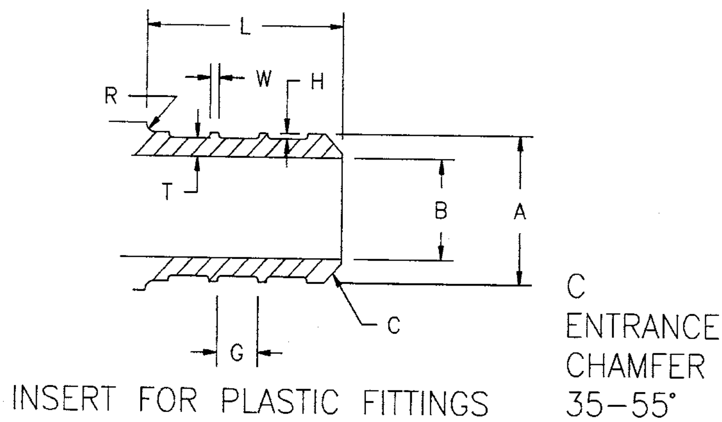
9.1 The sealing surfaces of the insert shall be smooth and free of foreign material. The fitting walls shall be free of cracks, holes, blisters, voids, foreign inclusions, or other defects that are visible to the unaided eye and that affect the wall integrity.

9.2 Except for the insert, the molded part shall be free of flash in excess of 0.005 in. Flash, mismatch, and witness mark requirements for the insert shall be in accordance with Fig. 1.

TABLE 2 Minimum Hydrostatic Sustained Pressure Requirements for Fitting, Crimp Ring and PEX or PE-RT Tubing Assemblies[A,B]

Nominal Tubing Size	Pressure Required for Test, psig (kPa)	
in.	180°F	(82.2°C)
⅜	250	(1724)
½	195	(1344)
¾ and larger	190	(1310)

[A] The fiber stress to derive this test pressure is: 770 psi (5.31 MPa) at 180° F (82.2°C).
[B] Test duration is 1000 h.



SIZE	A OUTSIDE DIAMETER	B MINIMUM ID	L INSERT LENGTH[B]	H MINIMUM RIB HEIGHT	NUMBER OF RIBS[E]	W RIB WIDTH TYP	G GAP WIDTH TYP	T MINIMUM WALL[A]	R MINIMUM RADIUS	MAXIMUM FLASH AND MISMATCH TOTAL ON CREST DIAMETER[C,D]
3/8"	0.347± .003	0.197	0.70+.020	0.015	2	0.03-0.05	0.135-0.152	0.050	0.03	0.005
1/2"	0.473± .003	0.315	0.70+.020	0.015	2	0.03-0.05	0.135-0.152	0.056	0.03	0.005
3/4"	0.668± .003	0.460	0.70+.020	0.015	2	0.03-0.05	0.135-0.152	0.082	0.03	0.005
1"	0.856± .003	0.610	0.85+.020	0.015	3	0.03-0.05	0.135-0.152	0.100	0.03	0.005

[A] APPLIES TO ENTIRE FITTING NOT JUST INSERT AREA.
[B] FITTING SHALL BE DESIGNED WITH SUFFICIENT OVERALL DIMENSIONS TO ALLOW PROPER USE OF CRIMP TOOL WITHOUT INTERFERENCE WITH PREVIOUSLY COMPLETED CRIMPS ON THE SAME FITTING.
[C] THE MAXIMUM FLASH AND MISMATCH AT THE ROOT DIAMETER BETWEEN THE RIBS MAY NOT EXCEED 30% OF THE RIB HEIGHT.
[D] THE TOTAL FLASH AND MISMATCH IS ASSUMED TO BE THE DIFFERENCE BETWEEN THE DIMENSIONS X AND Y (SEE FIG. 1A). THESE DIMENSIONS MAY BE MEASURED WITH APPROPRIATE CALIPERS OR MICROMETERS. SEE FIG. 1B FOR A GRAPHIC DEFINITION OF FLASH AND MISMATCH CREATED BY IMPERFECTION IN DIE HALF INTERFACES.
[E] LEAD CHAMFER AREA IS NOT CONSIDERED A RIB.
[F] THE MINIMUM ID SHALL BE MAINTAINED THROUGH THE INSERT LENGTH AND INTO THE FITTING, INTERSECTING THE MINIMUM ID OF THE OTHER FITTING INSERT(S).

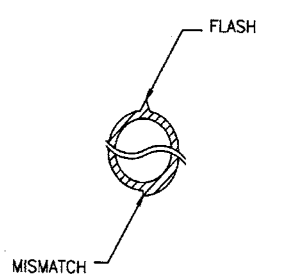


FIG. 1A FLASH AND MISMATCH CREATED BY IMPERFECTION IN DIE HALF INTERFACES.

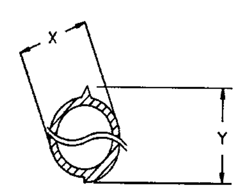


FIG. 1B TOTAL FLASH AND MISMATCH

FIG. 1 Fitting Insert Dimensions and Tolerances

10. Assembly

10.1 *Crimp Joints*—Insert fittings shall be joined to PEX tubing or PE-RT tubing by the compression of a copper crimp ring around the outer circumference of the tubing forcing the tubing material into annular spaces formed by ribs on the fitting. Insert fittings and crimp rings shall meet the dimensional and material requirements of this standard. PEX tubing shall meet the requirements of Specifications F876 or F877. PE-RT tubing shall meet the requirements of Specifications F2623 and F2769. The dimensions and out-of-roundness of the crimp ring after it has been crimped shall be in accordance with Table 3.

10.1.1 *Crimping Procedure*—To affix the insert fitting to the tubing with the crimp ring, the crimping procedure shall be as follows: slide the crimp ring onto the tubing, insert the ribbed end of the fitting into the end of the tubing until the tubing

TABLE 3 Crimp Ring Dimensions After Crimping on Tube/Fitting Assembly

Nominal Tube Size Insert End	Final Crimped Outside Diameter[A,B]	
	Minimum, in. (mm)	Maximum, in. (mm)
⅜	0.580 (14.7)	0.595 (15.1)
½	0.700 (17.8)	0.715 (18.2)
¾	0.945 (24.0)	0.960 (24.4)
1	1.175 (29.8)	1.190 (30.2)

[A] For all diameters except for the area of scoring caused by the crimping tool.
[B] The maximum out-of-roundness as measured by the difference between the minimum crimped outside diameter and the maximum crimped outside diameter shall not exceed 0.006 in. (0.150 mm).

contacts the shoulder of the fitting or tube stop. The crimp ring shall then be positioned on the tubing so the edge of the crimp ring is ⅛ in. to ¼ in. (3.2 to 6.4 mm) from the end of the tube. The jaws of the crimping tool shall be centered over the crimp ring and the tool shall be held so that the crimping jaws are approximately perpendicular to the axis of the barb. The jaws of the crimping tool shall be closed around the crimp ring, compressing the crimp ring onto the tubing. The crimp ring shall not be crimped more than once. Each crimp shall be checked to determine conformance to the after crimped dimensional requirements of Table 3.

11. Test Methods

11.1 *Conditioning*—Condition specimens at 73 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity for not less than 4 h prior to testing. Test Method D618 shall be used to the extent possible as a guide to other conditions.

11.2 *Test Conditions*—Conduct the tests in the standard laboratory atmosphere at 73 ± 4°F (23 ± 2°C) and 50±5 % relative humidity unless otherwise specified in the test methods or in this specification.

11.3 *Sampling*—A sample of the fittings, crimp rings, and PEX tubing sufficient to determine conformance with this specification shall be taken at random.

11.4 *Dimensions*—Any randomly selected fitting or fittings and crimp ring or crimp rings shall be used to determine dimensions. Measurements shall be made in accordance with Test Method D2122. Determine the diameters by making measurements at four locations spaced at approximately 45° apart around the circumference.

11.5 *Burst Pressure*—Determine the minimum burst pressure in accordance with Test Method D1599 on at least six assemblies for each temperature in Table 1. Leakage or separation at any of the joints tested, or from the fitting itself, at less than the minimum burst requirements for the temperatures specified in Table 1 shall constitute a failure in this test.

11.6 *Sustained Hydrostatic Pressure*—Perform the test on at least six assemblies in accordance with Test Method D1598, except for the following:

11.6.1 Test temperature shall be 180 ± 4°F (82 ± 2°C).

11.6.2 The external test environment shall be air or water.

11.6.3 Fill the specimens with water at a temperature of at least 120°F (50°C).

11.6.4 Leakage or separation at any joint tested at less than 1000 h at the sustained pressure as given in Table 2 shall constitute failure in this test.

11.7 *Thermocycling*:

11.7.1 *Summary of Test Method*—This test method describes a pass-fail test for thermally cycling assemblies comprised of insert fitting, crimp ring, and PEX tubing over a critical temperature range for a selected number of cycles while subjected to an internal pressure. The test provides a measure of resistance to failure due to the combined effects of differential thermal expansion and creep of connections intended for use up to and including 180°F (82°C).

11.7.2 *Apparatus*—A pressure source capable of maintaining an internal pressure of 100 ± 10 psi (690 ± 69 kPa) on the specimens is required. An immersion system shall consist of two water reservoirs controlled at 60 ± 4°F (16 ± 2°C) and 180 ± 4°F (82 ± 2°C) into which the pressurized specimens will be immersed. Either samples are cycled manually using flexible connectors or alternately the hot and cold water is cycled over the test specimens automatically and returned to the proper reservoir (Note 2).

NOTE 2—Automatic recycling may be accomplished by pumping from each reservoir through a delivery system having timer-actuated valves to specimen troughs having synchronized, timer-actuated return drains. Any automatic apparatus shall provide for complete immersion of the test specimen in the water.

11.7.3 *Specimen Assembly*—Test six assemblies. Attach the assemblies to a common manifold in such a way to allow free-end movement of the tubing. Close this specimen assembly with any suitable end closure that will allow free-end mounting and will not leak under the thermocycle conditions, and connect the specimen assembly to the pressure source.

11.7.4 *Procedure*—Pressurize the specimen assembly with air to 100 ± 10 psi (690 ± 69 kPa) and check for leaks. Eliminate any leaks before the thermocycle test is started. Thermally cycle the specimen assembly either manually or automatically and under a constant internal pressure of 100 ± 10 psi (690 ± 69 kPa), alternately between 60 ± 4°F (16 ± 2°C) and 180 ± 4°F (82 ± 2°C) by means of immersion in water using the following test cycle (Note 3):

Water immersion at 180°F	2 min minimum
Air immersion at ambient	2 min maximum
Water immersion at 60°F	2 min minimum
Air immersion at ambient	2 min maximum

NOTE 3—If the test must be interrupted before completion, samples are to be kept at room temperature until the test is restarted.

11.7.4.1 Upon completion of 1000 cycles, visually inspect for leaks while under the test pressure. Any evidence of leakage at the fittings or separation of the fittings from the tubing constitutes failure.

11.7.4.2 If no failures are evident, the specimen assembly shall immediately be tested for joint integrity (hydrostatic burst) at 73°F (23°C) in accordance with Test Method D1599. Leakage or separation during the hydrostatic burst test of any of the joints in the assembly at less than the pressure shown in Table 2 shall constitute failure of this test.

11.7.5 *Interpretation of Results*—Failure of any one of six specimens in the assembly shall constitute failure of this test.

11.8 *Excessive Temperature and Pressure Capability*—Test six assemblies in accordance with Test Method D1598, except for the following:

11.8.1 Test temperature shall be 210 ± 4°F (99 ± 2°C).

11.8.2 The external test environment shall be air.

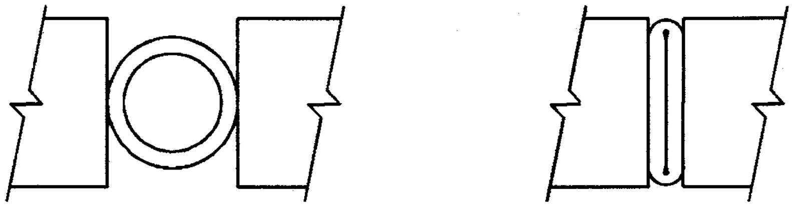


FIG. 2 Insert Crush Test

11.8.3 Fill specimens with water at a temperature of at least 120°F (50°C).

11.8.4 Pressurize the assemblies to 150 psi (1034 kPa) and maintain for 30 days (720 h). Leakage or separation of any joint tested shall constitute failure of this test.

12. Molded Part Properties Test Methods

12.1 *Insert Crush Test*— Under ambient conditions, test six fittings of each size in accordance with 12.1.1.

12.1.1 *Procedure*—Using a bench vise or other suitable compression device, place the insert of the fitting between the jaws of the vise. Close the jaws of the vise deforming the insert until the opposing inside walls of the insert touch. The insert shall not crack, split, or shatter, see Fig. 2.

13. Retest

13.1 If any failure occurs, a retest shall be conducted only if agreed upon between the purchaser and the seller. Failure in the retest is cause for rejection of the shipment.

14. Quality Assurance

14.1 When the product or product packing is marked with the ASTM designation F2159, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

15. Product Marking

15.1 *Quality of Marking*—The marking shall be applied to the fittings in such a manner that it remains legible after installation and inspection.

15.2 *Content of Marking*:

15.2.1 Marking on fittings shall include manufacturer's name or trademark, or some other identifying mark, material designation, and ASTM F2159.

15.2.1.1 Where recessed marking is used on fittings, care shall be taken to see that in no case shall the marking cause cracks or reduce the wall thickness below the minimum specified.

15.2.2 Marking on packaging shall include manufacturer's name, fitting size, and ASTM F2159.

15.2.3 Marking on crimp rings shall include manufacturer's trademark or some other identifying mark and PEX/PE-RT.

16. Keywords

16.1 cold- and hot-water distribution; copper crimp rings; cross-linked polyethylene; plastic insert fittings; PE-RT, polyethylene of raised temperature; PEX

APPENDIX

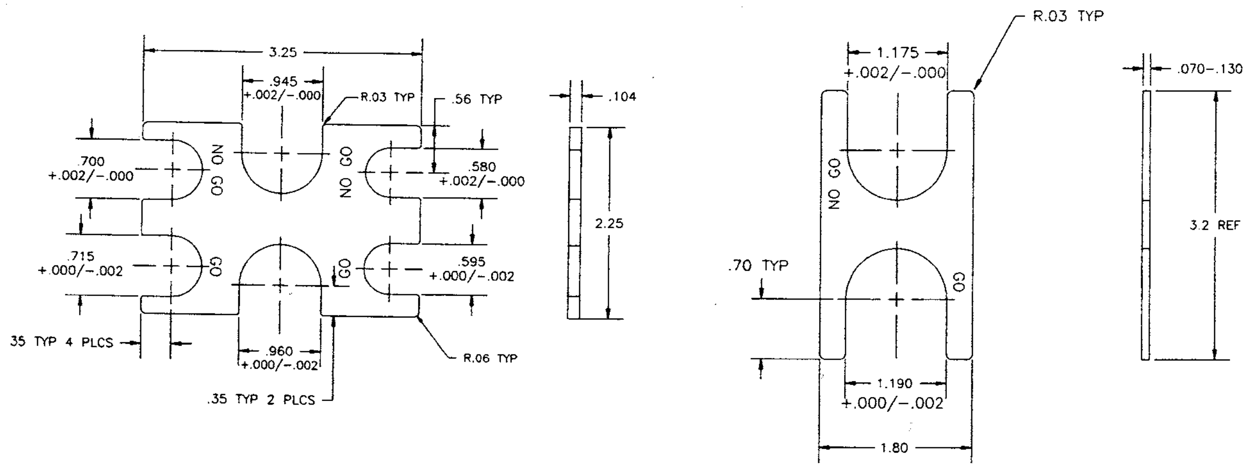
(Nonmandatory Information)

X1. GO/NO-GO CRIMP GAGE

X1.1 This appendix provides dimensions for gages to check the after-crimped dimensions of the three sizes of crimp connections governed by this standard. This information has been taken from gages in current production at the time of the writing of this standard. Gages shown here provide only a reference for the maximum and minimum diameters of the crimped ring and do not provide a check for the out-of-round dimension. Additionally, calipers or micrometers may also be used.

X1.2 Crimp gages manufactured according to the dimensions shown in Fig. X1.1 will ensure that crimps checked with these gages will not be larger or smaller than those allowed by this standard.

X1.3 *Use of the Crimp GO/NO-GO Gage*—Slide the correct size GO section of the gage over the crimped ring in at least two places and attempt to slide the NO-GO section of the gage over the crimped ring in at least two places (see Note X1.1). The GO section of the gage should slide over the crimped ring easily and the NO-GO section should not slide over the crimped ring. If the GO section does not slide over the ring, or the NO-GO section slides over the ring, the crimped joint must be replaced. Additionally, the crimp tool may need adjustment, follow the recommendations of the tool manufacturer.



3/8"-1/2"-3/4"GO/NO-GOGages ***1" GO/NO GO***

FIG. X1.1 GO/NO-GO Gage

NOTE X1.1—Most of the commercially available crimp tools will produce a scoring mark on the ring where the jaws of the tool overlap. Gaging the crimped ring on this scoring mark will generally give a false reading. Gage the crimped ring away from the scoring mark for best accuracy.

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F2159-09) that may impact the use of this standard.

(*1*) The title was revised.
(*2*) Sections 1, 2, 4, 7, 10, 15, and 16 were reviseed.
(*3*) The titles of Table 1 and Table 2 were revised.